JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 7 1984-85

Journal of the

Adelaide Botanic Gardens

Vol. 7

Dates of publication

Part 1	19 June, 1984
Part 2	27 March, 1985
Part 3	15 July, 1985

Volume 7

Contents

JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 7 Part 1

19 June, 1984

Instructions to Authors

Topics

Papers will be accepted in the following categories:

(a) Plant systematics (Australian and horticultural groups); (b) Descriptive plant morphology, anatomy and ecology; (c) Obituaries, biography and history; (d) Bibliographic studies, book reviews; (e) Botanical illustrations; (f) Noteworthy horticultural contributions. Preference will be given to unpublished material of suitable standard not intended for publication elsewhere.

Copy

Manuscripts must be typed, with double spacing and margins at least 3 cm wide, on one side of the paper only. Three copies must be submitted. Captions must not be italicized, underlined or typed in capitals. All scientific names of generic or lower rank must be underlined.

The print area for illustrations is 18 x 13 cm (excluding captions). Half-tone material should be submitted this size if possible, but will be reduced by the printers, if necessary.

Reprints

50 copies of reprints will be provided for each paper. Additional reprints may be purchased at cost.

Layout

The pattern of the paper should generally be:

(i) Title; (ii) Author and Address; (iii) Abstract (except for short papers); (iv) Introduction and subject matter; (v) Acknowledgements; (vii) References.

References

Text references to publications should be indicated as follows: (Smith, 1959), (Smith, 1959, p. 127), Smith (1959) or Smith (1959, pp. 125-208). The final section of the paper, headed 'References', should include only those titles referred to in this way. It should be laid out as follows:

Smith, L. L. (1879). The species of *Danthonia* found in pastures in Victoria. *Austral. J. Bot.* 65: 28-53.

Bentham, G. (1868). "Flora Australiensis", Vol. 4. (L. Reeve: London).

Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).

Journal abbreviations must be consistent within a paper and authors are recommended to follow "Botanico-Periodicum-Huntianum". Journals not cited in B-P-H should be abbreviated to conform with this general pattern. The following abbreviations for Australian states should be used: WA, NT, SA, Qld, NSW, ACT, Vic., Tas.

Text references to specimens should be italicized, for example *Kock 276*.

Indices

When required, follow the pattern on, for example, p. 106 of vol. 1, pt. 2.

Recommendations on taxonomic papers

Synonymy

Authors are requested to include in the synonymy only references to publications containing information additional to that to be published in the paper being submitted. Within this section journal and book titles must be conistently abbreviated. B-P-H journal abbreviations and book titles abbreviated in a similar way are desirable. Authors of references cited in the synonymy should preferably be abbreviated according to the 'Index of Author Abbreviations' compiled and published by Royal Botanic Gardens, Kew (1980). References may be cited as:

Benth., *Fl. Austral.* 4: 111 (1868) OR

Benth., *Fl. Austral.* 4: (1868) 111.

Citation of specimens

10-30 specimens should be cited for each species (or subspecific taxon), although this may be varied under certain circumstances. The author may decide whether or not to include dates of collections and the sequence, provided a constant pattern is adhered to throughout a paper.

Authors wishing to cite all specimens seen may list them all in an index to collectors after the style of the "Flora Malesiana" identification lists. Collections not identifiable by a collection number (assigned by either the collector or herbarium) should cite dates.

Correspondence

All correspondence concerning the journal should be addressed to:

The Director, Adelaide Botanic Gardens, North Terrace, ADELAIDE, South Australia 5000.

ISSN 0313-4083

J. Adelaide Bot. Gard. (7): 1-44 (1984)

A TAXONOMIC REVISION OF THE GENUS *PREMNA* L. (VERBENACEAE)* IN AUSTRALIA

Ahmad Abid Munir

State Herbarium, Botanic Gardens,
North Terrace, Adelaide, South Australia 5000

Abstract

A taxonomic revision of *Premna* in Australia is presented. The following seven species are recognised: *P. herbacea*, *P. serratifolia*, *P. lignum-vitae*, *P. dallachyana*, *P. hylandiana*, *P. acuminata* and *P. odorata*. *P. hylandiana* (from Queensland) is described as new and *P. odorata* is recorded from Australia for the first time. *P. serratifolia* is reinstated as the oldest valid name for the polymorphic species previously often named *P. integrifolia*, *P. obtusifolia* or *P. corymbosa*. A wide range of material of the non-endemic species has been examined from South-East Asia and Malesia.

The affinities and distribution are considered for the genus and each species. A key to the species is provided and a detailed description of each species is supplemented by a habit sketch of a flowering branch and analytical drawings of the flower.

Taxonomic History of the Genus

The genus *Premna* was described by Linnaeus (1771) for two species, *P. integrifolia* and *P. serratifolia*, which were collected by Paul Hermann in Ceylon. It was placed in "Didynamia Angiosperma", where it was retained by Murray (1774), Gmelin (1791), Schreber (1791), Persoon (1797), Willdenow (1800), Poiret (1823), Sprengel (1825, 1831), Roxburgh (1832), Blanco (1837), Dietrich (1843) and a few others. Scopoli (1777) placed it in "Personatar" which was later accepted for the genus by Giseke (1792) and Batsch (1802). Gaertner (1788) recorded it in "Centuria Quarta", Jussieu (1789) in "Vitices", Necker (1790) in this "Plasyrgophyta", and Reichenbach (1828) under the tribe "Verbeneae" in the Labiatae. In 1806, de Jussieu referred it to the family Verbenaceae where it has been retained by the majority of botanists.

Bartling (1830) split the Verbenaceae into two sections:- Viticea and Verbenea, with *Premna* in the section Viticea. This section was accepted for the genus by Spach (1840). In 1836, Endlicher divided the family into three tribes:- Lippieae, Lantaneae and Aegiphileae, with *Premna* in the tribe Lantaneae. This tribe was accepted for the genus by Meisner (1840), Endlicher (1841), Brongniart (1843), Dietrich (1843) and Walpers (1845). Schauer (1847) classified the Verbenaceae into three new tribes:- Verbeneae, Viticeae and Avicennieae, with *Premna* in the tribe Viticeae. The genus was retained in the new tribe by Walpers (1852), Miquel (1858), Bentham (1870), Bentham & Hooker (1876), Bailey (1883, 1901, 1913), Hooker (1885), Durand (1888), King & Gamble (1909), Ewart & Davies (1917), Fletcher (1938), Lemée (1943) and a few others. Schauer (1847) subdivided the tribe Viticeae into three subtribes:- Symphoremeae, Caryopterideae and Viticeae, with *Premna* in the subtribe Viticeae. He also split the genus into two sections:- *Gumira* and *Premnos*, based chiefly on their calyx being regularly 4- or 5-toothed. The subtribe Viticeae was later accepted for the genus by Miquel (1858) and Bentham (1870), and the division of the genus into two sections was adopted by Miquel (1858), H.J. Lam (1919), Moldenke (1959, 1971) and a few others.

In 1895, Briquet reclassified the Verbenaceae and upgraded the tribe Viticeae to a sub-family Viticoideae. The latter consisted of four tribes:- Callicarpeae, Tectoneae, Viticeae and Clerodendreae, with *Premna* in the tribe Viticeae. This classification was adopted by

*The present treatment of the genus *Premna* is the second in the series of taxonomic revision in the family Verbenaceae in Australia (See Munir, 1982).

Dalla Torre & Harms (1904), H.J. Lam (1919), Gardner (1931), Junell (1934), Moldenke (1959, 1971) and Melchior (1964). In the same treatment, Briquet (1895) subdivided the genus into five sections:- *Holopremna*, *Odontopremna*, *Gumira*, *Premnos* and *Holochiloma*, each characterised chiefly by the size and number of their calyx-lobes. These sections were adopted by Dalla Torre & Harms (1904). The majority of botanists, however, have not divided the genus into sections, but have retained it in the Verbenaceae without reference to any subfamily or a tribe. In the present work, Briquet's (1895) classification of the Verbenaceae is followed in retaining *Premna* in the tribe Viticeae. The subgeneric sections proposed for the genus, however, are not accepted because of the unreliability of characters used.

Australian History of the Genus

The first Australian records of *Premna* were made by Robert Brown (1810) from northern Queensland, when he described six new species:- *P. obtusifolia*, *P. attenuata*, *P. media*, *P. ovata*, *P. acuminata*, and *P. cordata*. Of these, *P. cordata* and *P. acuminata* were later identified as one species and the remaining four as synonyms of *P. serratifolia* L. In 1847, Schauer recorded all of Robert Brown's *Premna* species from Australia under "Species denuo recognoscendae". He did not elaborate on their short original descriptions, nor cite any plant collections from Australia. J.D. Hooker (1858) listed *P. serratifolia* L. from tropical Australia, and F. Mueller (1862) recorded three *Premna* species from Queensland, namely *P. glycycocca* F. Muell., *P. acuminata* R. Br. and *P. lignum-vitae* (A. Cunn. ex Schau.) Pieper (= *Vitex lignum-vitae* A. Cunn. ex Schau.). Of these, *P. glycycocca* was described as a new species but it was later found to be conspecific with *P. serratifolia*. In 1870, Bentham published a detailed account of the Australian Verbenaceae, and listed five *Premna* species:- *P. obtusifolia* R. Br., *P. integrifolia* L., *P. limbata* Benth., *P. dallachyana* and *P. acuminata* R. Br. Subsequently, the occurrence of these species in Australia was recorded by F. Mueller (1882, 1889) and Bailey (1883, 1901, 1913). Of these *P. obtusifolia*, *P. integrifolia* and *P. limbata* were later found to be synonymous with *P. serratifolia*. In 1883, F. Mueller described a new genus *Tatea*, based on two collections from Arnhem Land, Northern Territory. The type species was named *T. subacaulis* F. Muell., and the genus was considered allied to *Premna*. The genus *Tatea* and its type species were later found to be synonymous with *Premna* L. and *P. herbacea* Roxb. respectively. Moldenke (1959, 1871, 1980, 1983), however, reduced *Tatea* F. Muell. to *Pygmaeopremna* Merr. which he recognised as valid. He, therefore, transferred *T. subacaulis* F. Muell. to *Pygmaeopremna* making a new combination *Pygmaeopremna subacaulis* (F. Muell.) Mold. Domin (1929) listed from Australia six *Premna* species:- *P. obtusifolia*, *P. benthamiana* Domin, *P. suavis* Domin, *P. minor* Domin, *P. acuminata*, *P. dallachyana* var. *typica* and var. *obtusisepala* Domin. In this list, *P. benthamiana* was described as a new name, *P. minor* and *P. suavis* as new species and *P. dallachyana* var. *obtusisepala* as a new variety. All these taxa described by Domin were later recorded for Australia by Moldenke (1959, 1971, 1980).

In the present treatment, Briquet's (1895) classification of the Verbenaceae is accepted for the genus. *Tatea* and *Pygmaeopremna* are placed in the synonymy of *Premna*. *P. serratifolia* is accepted as the oldest validly published name for the widely distributed polymorphic species, named by others as *P. integrifolia* L., *P. obtusifolia* R. Br. or *P. corymbosa* (Burm. f.) Rottl. & Willd. *P. limbata* Benth. and *P. suavis* Domin are recorded as new synonyms of *P. serratifolia*. Similarly, *P. minor* Domin and *P. tateana* Bail. are found to be the new synonyms of *P. dallachyana*, and *P. dallachyana* var. *obtusisepala* Domin is considered to be identical with the typical variety. Moreover, *P. obtusifolia* R. Br. var. *velutina* Benth., and *Gumira odorata* (Blanco) Kuntze are regarded as new synonyms of *P. odorata* Blanco. In all seven species are recognised of which one from Queensland is newly described.

PREMNA L., nom. cons.

Premna L., Mant. 2 (1771) 154; Willd., Sp. Pl. 3 (1800) 314, no. 1164; R. Br., Prod. Fl. Nov. Holl. (1810) 512; Blume, Bijdr. Fl. Ned. Ind. (1826) 815; Roxb., Fl. Ind. 3 (1832) 75; Endl., Gen. Pl. 2 (1836) 636, no. 3701; Meisner, Pl. Vasc. Gen. 1 Tab. Diag. (1840) 291; Pl. Vasc. Gen. 2. Comment. (1840) 199; Steudel, Nom. Bot. 2 (1841) 392; Schau. in DC., Prod. 11 (1847) 630; Miq., Fl. Ind. Bat. 2 (1858) 890; Benth., Fl. Aust. 5 (1870) 58; H. Pfeiffer, Nomen. Bot. 2, Part 1 (1874) 832; Benth. & Hook. f., Gen. Pl. 2 (1876) 1152; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 377; C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 571; Briq. in Engl. & Prantl, Pflanzenfam. 4, 3a (1895) 170; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; F.M. Bail., Qld Fl. 4 (1901) 1175; H.J. Lam, Verbenac. Malay. Arch. (1919) 100; Junell, Symb. Bot. Ups. 4 (1934) 84; Lemée, Dict. Descrip. Syn. Gen. Pl. Phan. 8b (1943) 656; Merr., J. Arn. Arb. 32 (1951) 73-78; Mold., Résumé Verbenac. etc. (1959) 236, 275, 276, 297, 299, 320, 333, 343, 397, 398, 409; N. Burb., Dict. Aust. Pl. Gen. (1963) 243; Backer & Bakh. f., Fl. Java 2 (1965) 602; Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 390, 395, 469, 471, 525, 528, 572, 600, 618-620, 642, 741, 742, 758; Farr et al., Index Nom. Gen. Pl. 3 (1979) 1408; Mold., Sixth Summary Verbenac. etc. (1980) 395, 409, 432, 434.

Type: *P. serratifolia* L., Mant. 2 (1771) 253, *typ. cons.*

[*Cornutioides* L., Fl. Zeyl. (1747) 195.]

Type: Not specified.

Gumira [Rumph., Herb. Amb. 3 (1743) 208, t. 133] Hassk. in Flora 25, Beibl. 2 (1842) 26; Hort. Bogor (1844) 135; Kuntze, Rev. Gen. Pl. 2 (1891) 507.

Type: *G. domestica* Rumph. ex Hassk., Flora 25 (1842) Beibl. 2: 26.

Scrophularioides Forst. f., Prod. (1786) 91.

Type: Not known.

Baldingera Dennst., Schlüssel Hort. Malab. (1818) 31.

Type: Not known.

Holochiloma Hochst., Flora 24 (1841) 371.

Type: *H. resinosum* Hochst. loc. cit. (1841) 371.

Phaenicanthus Thwaites, Enum. Pl. Zeyl. (1861) 242.

Type: *P. zeylanicus* Thwaites, loc. cit. (1861) 242.

Tatea F. Muell., Trans. & Proc. Roy. Soc. S. Aust. 6 (1883) 33; Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Merr., J. Arn. Arb. 32 (1951) 73, pro syn.

Type: *T. subacaulis* F. Muell., Trans. & Proc. Roy. Soc. S. Aust. 6 (1883) 34.

Pygmaeopremna Merr., Philipp. J. Sc. (Bot.) 5 (1910) 225; H.J. Lam, Verbenac. Malay. Arch. (1919) 160; Merr., J. Arn. Arb. 32 (1951) 73; Mold., Résumé Verbenac. etc. (1959) 341, 353, 409; N. Burb., Dict. Aust. Pl. Gen. (1963) 248, pro syn.; Mold., Fifth Summary Verbenac. etc. 2 (1971) 614, 640, 758; Sixth Summary Verbenac. etc. (1980) 435; Mold. in Dassan. & Fosb., Fl. Ceylon 4 (1983) 344; Munir in Morley & Toelken, Fl. Pl. Aust. (1983) 288.

Type: *P. humilis* Merr., Philipp. J. Sc. (Bot.) 5 (1910) 225.

Shrubs, trees or undershrubs. *Stem* and branches almost terete or obscurely tetragonal, main trunk often with fissured flaky bark. *Leaves* simple, decussate, exstipulate, reticulate-veined, unicostate, petiolate, or sessile. *Inflorescence* cymose, compound and often much branched, terminal, pedunculate. *Flowers* small, complete, zygomorphic, bisexual, hypogynous; bracts small, narrow. *Calyx* of 4-fused sepals, persistent, tubular or somewhat

campanulate, variously toothed or truncate, often more or less 2-lipped, with one lip entire or 2-toothed, the other entire or 3-toothed, not accrescent. *Corolla* of 4-fused petals, deciduous, tubular below, more or less 2-lipped above; upper lip usually entire, rarely 2-lobed; lower one 3-lobed, with the middle lobe larger; tube usually densely villous in the upper half. *Stamens* 4, didynamous, alternate with the corolla-lobes, epipetalous, inserted about the middle of the corolla-tube; filaments filiform, glabrous; anthers dorsifixed, oblong or elliptic, 2-lobed, lobes parallel or divergent. *Ovary* bicarpellary, syncarpous, 4-locular, with one ovule in each cell attached to an axile placenta at or above the middle; style filiform, with 2 short stigmatic lobes. *Fruit* a small globose succulent drupe, with a hard 4-celled undivided kernel. *Seeds* exalbuminous.

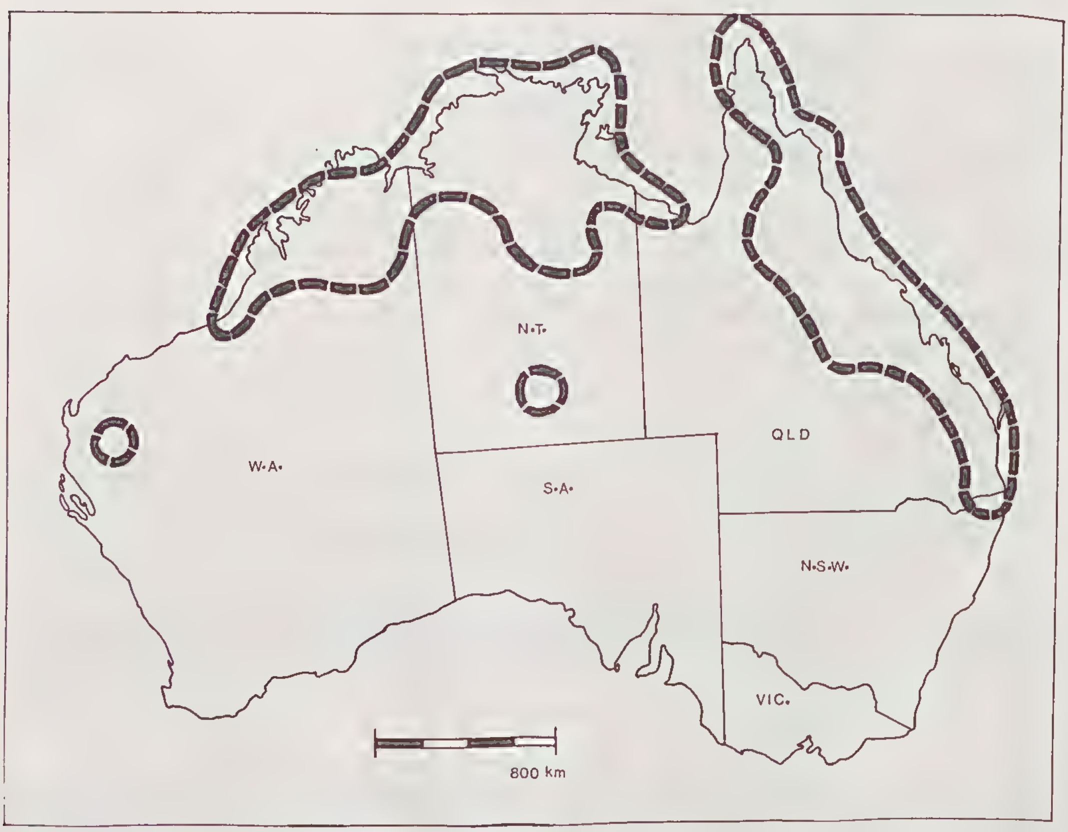
Number of species: World: ± 200; Australia: 7

Derivation of name

The generic name is derived from the Greek *Premnon*, the stump of a tree; alluding to the dwarf size of the type species.

Distribution (Map 1)

The genus *Premna* is widely distributed in the tropical and subtropical regions of



Map 1. Distribution of the genus *Premna* L. in Australia.

Australia, Africa and Asia. The main distribution, however, extends from India to Japan, southward to Indochina, Malesia, tropical Australia and eastward to Polynesia. So far, it has not been recorded from Europe, America, New Zealand, Central and Southern Australia, except in cultivation.

Of the seven Australian species three are endemic in Australia and the other four are wide-spread in Malesia. The distribution of at least one of these species (*P. serratifolia* L.) extends to East Africa, India, southern China and Japan. *P. herbacea* Roxb. is the second most wide-spread species occurring from India and Southern China to the Philippines, and extending southwards to Northern Australia.

Comments

The genus *Premna* was considered by Beer & H.J. Lam (1936) as an "extremely difficult genus, in which flower features are almost as vague and little distinct as those of the extremely variable leaves". Such polymorphic species have been described by botanists under different names. The leaves in particular are found to be highly variable in shape and size, but the flowers and fruits were fairly constant in the species investigated. Regarding the Australian species, Bentham (1870) remarked that:- "there are a number of forms including *P. integrifolia* and *P. serratifolia* of Linnaeus which seem to pass into each other by numerous intermediates, and it would require a much more detailed study of good specimens from different localities . . . . .".

Schumann (1889) observed that Schauer (1847) and other authors before him maintained or described a great number of species, which should really be combined with *P. integrifolia*, such as *P. sambucina* and *P. gaudichaudii*. H.J. Lam (1919) agreed with Schumann's (1889) opinion in extending this principle. He also regarded *P. integrifolia* as "a very polymorphic species" and stated that:- "For, examining a large number of specimens, we found, that several other species were unseparably united with one another by all possible intermediate forms and with *P. integrifolia*, such as *P. foetida* Reinw., *P. laevigata* Miq., *P. nitida* Schum., *P. cyclophylla* Miq., *P. abbreviata* Miq., *P. opulifolia* Miq. So we thought to be justified to combine these species into one large and very polymorphic one, being called by the name of the eldest. Probably it will appear that some more species belong to this polymorphic species, such as *P. obtusifolia* R. Br. which has already been mentioned by Schumann". Regarding the separation of species solely on the forms of their calyces, H.J. Lam (1919) observed that:- "we see how impossible it is—as several other authors did—to subdivide the species exclusively basing upon the form of the calyx, which, as in some other species, is often inconstant, and can give rise only to the keeping of Hasskarl's Gumira and Premnos, subgenera, which also are not distinctly separated. This and some other polymorphic species in this family, as *Callicarpa cana* and especially *Avicennia officinalis*, may show once more, how wrong and unscientific it is to try to discover truths of any worth for the systematic botany by the old method, by a mere examination of often individual morphological characteristics, and how necessary to apply the science of genetics to the systematical branch of Botany. In this way we should find a new link between two branches of the sciences of nature; for to arrive at the understanding, based upon scientifically stipulated facts, that there is only one science of the things of Nature, we may consider as one of the highest ambitions of the man of science".

According to Moldenke (1971), there are still many problems, some of them very complex, remaining to be solved before we can claim to have anything like a solid understanding of the several plant families, including Verbenaceae. In his opinion, some genera, like *Premna*, have been over-described, and some of the present subgeneric grouping in *Premna*, *Stachytarpheta* and others of the same rank ought to be raised to generic level.

Briquet (1895) divided the genus into five sections, namely *Holopremna*, *Odontopremna*, *Gumira*, *Premnos* and *Holochiloma*, each characterised chiefly by the size and number of their calyx-lobes. It may be difficult to assign all Australian species entirely to any one section, but it seems that the majority of them would come under the section *Gumira*.

Dalla Torre & Harms (1904) referred the authority of the tribe Viticeae to Briquet (1895). On the other hand, Moldenke (1971) recorded the tribe Viticeae as being based on Bartling's (1830) section Viticea of the Verbenaceae. The upgrading of this section to a tribe, therefore, has been attributed to Bentham. Under an alphabetic list of the accepted "Group names", Moldenke (1971) has recorded it as:- "*Viticeae* (Bartl.) Benth.—a tribe in Verbenaceae J. St.-Hil." According to present investigations, however, the tribe Viticeae was earlier recognised by Schauer (1847) as one of the three tribes of the Verbenaceae.

In 1910, Merrill described a new genus *Pygmaeopremna*, based on two collections from Luzon, Philippines. The type species was named *P. humilis* Merr., and the genus was considered allied to *Premna* and *Vitex*, but more especially to the former. It was distinguished from *Premna* only by its very small size. Lam (1919) recognised *Pygmaeopremna* as valid, but at the end of his generic description noted: "Without regard to characteristics of less consequence, the genus differs from *Premna* only by its extraordinary small size; therefore perhaps we had better combine it with that genus". Subsequently, Lam and Bakhuizen (1921) expressed the opinion, that "*Pygmaeopremna* Merr. could not be distinguished from *Premna* L.", but they erroneously reduced *Pygmaeopremna humilis* Merr. to synonymy in *Premna timoriana* Decne. which is a shrub several metres high. After the above publications, Merrill reconsidered the status of his newly described genus *Pygmaeopremna* which he had originally placed in the herbarium as *Premna*. In 1923, Merrill not only reduced *Pygmaeopremna* to synonymy in *Premna*, but also reduced its type species to synonymy with the Indian *Premna herbacea* Roxb. In spite of Merrill's combining of *Pygmaeopremna* Merr. with *Premna* L., Moldenke (1959, 1971, 1981, 1983) retained the former as a distinct genus. Like Merrill (1910) and Lam (1919), Moldenke also distinguished this genus from *Premna* L. only by its small size.

During present investigations, the flowers of all available *Pygmaeopremna* collections were found to be similar to those of *Premna*. The only differential character that really holds is the dwarf habit of *Pygmaeopremna*, and this character is not good enough to recognise the genus. Therefore, following Merrill (1923, 1951) and others, *Pygmaeopremna* is regarded here a synonym of *Premna*.

Affinities

Premna is closely related to *Gmelina* L. as its inflorescence is terminal, corolla 2-lipped, fertile stamens 4, didynamous, fruit a drupe with 4-celled pyrene. Nevertheless, it can easily be distinguished by its corolla-tube being short and cylindrical. The corolla-tube in *Gmelina* is large, mostly infundibuliform and greatly ampliate above.

There are a few characters common between *Premna* and *Vitex* L. Both have a 2-lipped corolla with a short cylindrical tube, didynamous stamens and drupaceous fruit. However, *Vitex* can be easily identified by its leaves often being digitate with 3-7 leaflets, rarely 2 or 1, and corolla 5-lobed. Amongst other Australian genera of the Verbenaceae, *Callicarpa* L. seems close to *Premna* in having simple leaves, a cymose inflorescence, usually 4-lobed corolla with a short tube, 4 stamens and drupaceous fruit. The latter, however, can readily be identified by its cymes being arranged in a terminal panicle, the calyx and corolla more or less 2-lipped, stamens didynamous and drupe with 4-celled pyrene.

Key to the Species

1a. Undershrub 5-15 (-30) cm high; leaves sessile, with basal pair lying flat on the ground ....1. *P. herbacea*

b. Shrubs or trees more than 1 m high; leaves distinctly petiolate, with basal pair always high above the ground 2

2a. Leaves densely pubescent-tomentose, especially on the lower surface 5

b. Leaves glabrous, sometimes pubescent only on the principal veins 3

3a. Lamina oblong or oval-elliptic, cuneate at the base, adaxially shining or dull but often drying black; petiole often pubescent; pedicel usually more than 1 mm long; corolla purplish-red, pinkish-mauve or greenish-cream; fresh ripe fruit dark purple, reddish-purple or pink to pale red 4

b. Lamina broadly ovate, obovate or almost orbicular, rounded, obtuse or cordate at the base, often dull-brownish when dry; petiole mostly glabrous; pedicel up to 1 mm long; corolla greenish-white; fresh ripe fruit always green .... 2. *P. serratifolia*

4a. Lamina coriaceous, adaxially shining; pedicel 5-12 (-14) mm long; corolla tomentose outside, purplish-red or pinkish-mauve, 9-13 (-15) mm long; fruit (5-) 8-15 (-20) mm diam., pink, pale-red or reddish-purple when ripe .... 3. *P. lignum-vitae*

b. Lamina chartaceous, dull, often drying black; pedicel 1-2.5 mm long; corolla glabrous outside, greenish-cream, 4-7 mm long; fruit 3-5 mm diam., dark purple when ripe .... 4. *P. dallachyana*

5a. Lamina ovate-cordate, pubescent-tomentose with dendriform-stellate hairs; pedicel (1.5-) 2-3 (-5) mm long; corolla lobes creamy or pale yellow, tube almost equal to the calyx, glabrous outside; ovary glabrous, glandular on top .... 5. *P. hylandiana*

b. Lamina deltoid, rhomboid or ovate-subcordate, pubescent with unbranched simple hairs; pedicel 0.5-1.5 mm long; corolla lobes reddish, brick-red, greenish-white or pinkish-white, tube twice the length of the calyx, pubescent or nearly glabrescent outside; ovary glabrous, not glandular 6

6a. Lamina deltoid-rhomboid, much acuminate, entire or coarsely and irregularly dentate; inflorescence very lax; corolla 5-7 mm long, lobes reddish or brick-red; style 5-6 mm long .... 6. *P. acuminata*

b. Lamina ovate-rotundate, shortly cuspidate-acuminate, rounded or subcordate at the base, entire, rarely serrulate-denticulate in the upper; inflorescence not lax; corolla 3.5-5.5 mm long, lobes greenish- or pinkish-white; style 3-5 mm long .... 7. *P. odorata*

1. **Premna herbacea** Roxb., Hort. Beng. (1814) 46, *nom. nud.*; Fl. Ind. edn 2, 3 (1832) 80; Walp., Repert. Bot. Syst. 4 (1845) 96; Schau. in DC., Prod. 11 (1847) 736; Brand., For. Fl. N.W. Centr. Ind. (1874) 368; Gamble, Man. Ind. Timb. (1881) 535; C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 581; Brand., Ind. Trees (1906) 511; Craib, Kew Bull. (1911) 443; Duthie, Fl. Upper Ganget. Plain 2 (1911) 233; Dop, Bull. Soc. Bot. France 70 (1923) 830; Merr., Enum. Philipp. Fl. Pl. 3 (1923) 390; Pei, Mem. Sc. Soc. China 1 (1932) 71; Dop in Lecomte, Fl. Gen. Indochine 4 (1935) 815; Fletcher, Kew Bull. (1938) 404, 421; Merr., J. Arn. Arb. 32 (1951) 75; Haines, Bot. Bihar & Orissa 2, reprint edn (1961) 753; Prain, Beng. Pl. 2, reprint edn (1963) 620.

Type: *Dr William Carey s.n.*, collected from Dinagepore, Bengal, now Bangladesh, in 1801 and cultivated as "Bhoomi Jambooka" in the Botanical Gardens at Calcutta (K, n.v.).

P. sessilifolia H.J. Lam, Verbenac. Malay. Arch. (1919) 133; Beer & H.J. Lam, Blumea 2 (1936) 228; H.J. Lam, Blumea 5 (1945) 617.

Type: *Schlechter 18303*, near Kenegia River, alt. 150 m, New Guinea, 29.ix.1908 (BR, syntype!).

P. obovata Merr., J. Arn. Arb. 32 (1951) 77.

Type: *T.T. Yii 16431*, Yunnan Province, Shunning, Hila, China, 23.vi.1938 (A, holotype!).

P. acaulis (F. Muell.) Merr., J. Arn. Arb. 32 (1951) 75, based on *Tatea subacaulis* F. Muell. (1883). The original epithet was mis-spelt by F. Mueller as "*T. acaulis*" in his Syst. Cens. Suppl. 1 (1884) 3.

P. timoriana auct non Decne. (1834), non H. Hallier (1942): H.J. Lam in Merr., Enum. Philipp. Pl. 3 (1923) 390, pro syn.

P. humilis Merr. ex Mold., Résumé Suppl. 15 (1967) 22.

Type: As for *Pygmaeopremna humilis* Merr. (1910) 225.

Tatea acaulis F. Muell., Preprints Trans. Roy. Soc. S. Aust. April 1883. (The name *Tatea acaulis* F. Muell. first appeared in the preprints of F. Mueller's protologue of this species which were distributed in April 1883. The specific epithet altered to *T. subacaulis* F. Muell. was published in the Transactions of the Royal Society of South Australia in December 1883); F. Muell., Syst. Cens. Suppl. 1 (1884) 3; Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Ewart & Davies, Fl. N. Terr. (1917) 239; Junell, Symb. Bot. Ups. 4 (1934) 85; Merr., J. Arn. Arb. 35 (1951) 73-75, pro syn.

Type: *R. Tate s.n.*, along the route from Bridge Creek to McKinley River at twelve mile, on alluvial soil, Arnhem Land, Northern Territory, Australia, March 1882 (AD, K-syntypes!). *Foelsche s.n.*, near Yam Creek, Arnhem Land, Northern Territory, Australia, December 1882 (K, MEL-syntypes!).

T. subacaulis F. Muell., Trans. Roy. Soc. S. Aust. 6 (1883) 34.

Type: as for *T. acaulis* F. Muell. April 1883.

T. herbacea (Roxb.) Junell, Symb. Bot. Ups. 4 (1934) 85, based on *Premna herbacea* Roxb.; Meeuse, Blumea 5 (1942) 71.

T. humilis (Merr.) Junell, Symb. Bot. Ups. 4 (1934) 85, based on *Pygmaeopremna humilis* Merr.; Meeuse, Blumea 5 (1942) 71.

Gumira herbacea (Roxb.) Kuntze, Rev. Gen. Pl. 2 (1891) 507, based on *Premna herbacea* Roxb.

Pygmaeopremna humilis Merr., Philipp. J. Sc. (Bot.) 5 (1910) 225; H.J. Lam, Verbenac. Malay. Arch. (1919) 161; Meeuse, Blumea 5 (1942) 71; Merr., J. Arn. Arb. 32 (1951) 73-76, pro syn.; Mold., Résumé Verbenac. etc. (1959) 185, 339, 353.

Type: *Ramos B. Sc. 7841*, Province of Cagayan, Piat, Luzon, Philippines, 2.iv.1909 (A, K, US, syntypes!). *Ramos B. Sc. 8124*, Province of Isabella, Ilagan, Luzon, Philippines, 29.iv.1909 (K, NY, syntypes!; PNH, syntype, n.v., possibly destroyed during the War).

P. herbacea (Roxb.) Mold., Phytologia 2 (1941) 54, based on *Premna herbacea* Roxb.; Résumé Verbenac. etc. (1959) 160, 164, 174, 176, 178, 198, 202, 338, 339, 353; Sexena, Bull. Bot. Surv. India 12 (1970) 56, sphalm. "*Pygnacopremna herbacea*"; Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 270, 271, 278, 292, 297, 302, 318, 327, 330, 337, 607, 610, 611, 614, 640, 970, 971, 973; Phytologia 31 (1975) 399; Sixth Summary Verbenac. etc. (1980) 257, 258, 265, 273, 279, 282, 287, 290, 308, 317, 321, 339, 360, 386, 410, 432-435, 444; Mold. in Dassan & Fosb., Fl. Ceylon 4 (1983) 345.

Type: As for *Premna herbacea* Roxb. (1832) 80.

P. subacaulis (F. Muell.) Mold., Phytologia 2 (1941) 54, based on *Tatea subacaulis* F. Muell.; Résumé Verbenac. etc. (1959) 210, 353; Fifth Summary Verbenac. etc. 1 & 2 (1971) 348, 640; Green, Cens. Vasc. Pl. West. Aust. (1981) 89.

Type: As for *Tatea subacaulis* F. Muell. (1883) 34.

P. sessilifolia (H.J. Lam) Mold., Known Georgr. Distr. Verbenac. & Avicenniac. (1942) 78; Résumé Verbenac. etc. (1959) 195, 202, 339.

Type: As for *Premna sessilifolia* H.J. Lam (1919) 133.

P. obovata (Merr.) Mold., Sixth Summary Verbenac. etc. (1980) 433.

Type: As for *Premna obovata* Merr. (1951) 77.

Description (Fig. 1)

A low-growing perennial herb or a dwarf undershrub 5-15 (-30) cm high. *Stem* mostly underground with creeping woody rhizome, the above ground part simple or dichotomously once branched, terete, slender, the branchlets pale or dark-brown, puberulous. *Leaves* opposite, sessile or subsessile, with basal leaves lying flat on ground, ± forming a

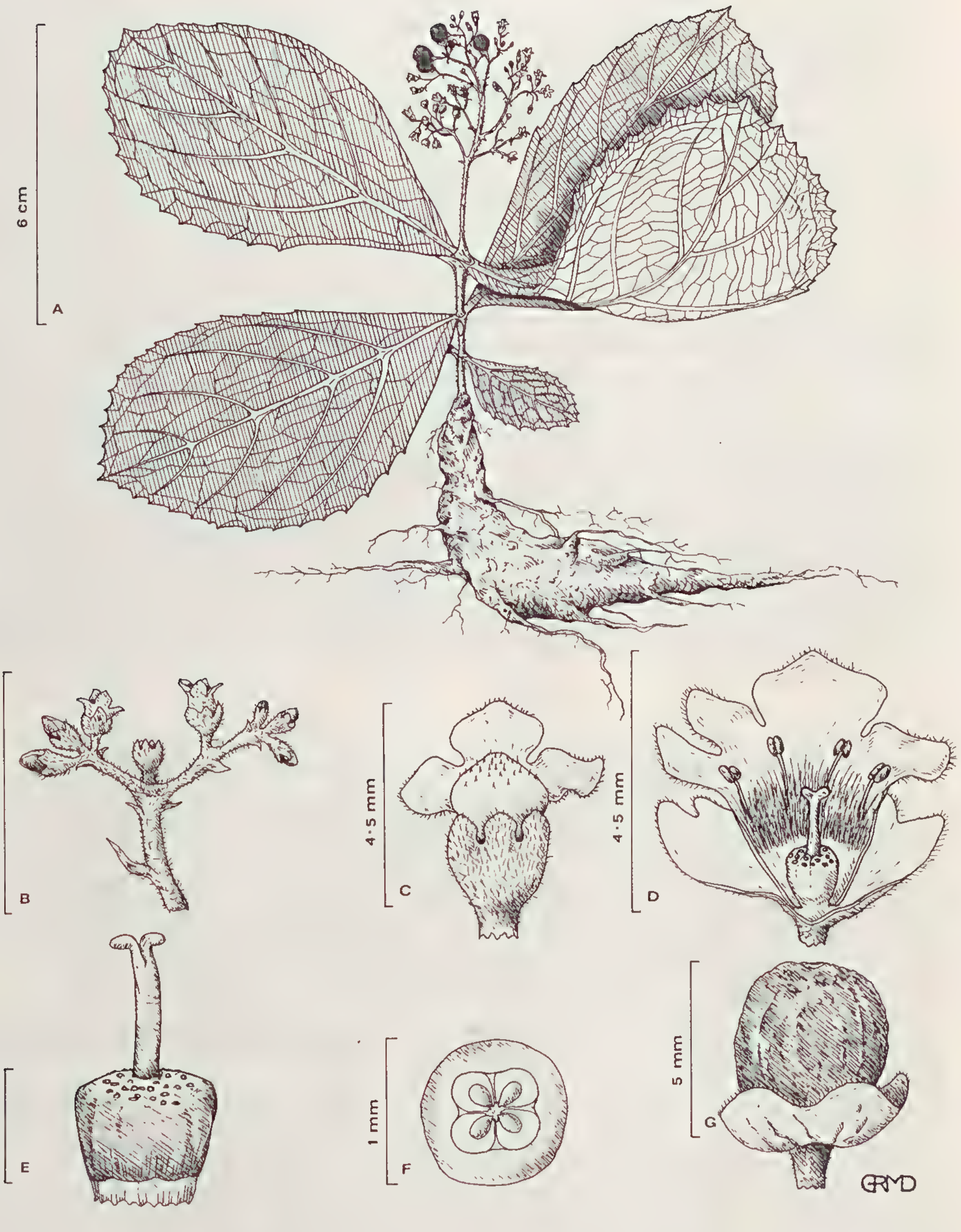


Fig. 1. *Premna herbacea* Roxb. (A-G, *Adams 849*: CANB). A, habit sketch; B, cyme; C, flower; D, flower vertically cut open to show androecium and gynoecium; E, ovary; F, transverse section of ovary; G, fruit with persistent calyx.

rosette, obovate, obtuse, gradually narrowing towards the base, dentate or crenate-undulate in the upper half, entire in the lower (cuneiform) half, (3-) 5-12 (-14) cm long, (2-) 3-7 (-10) cm broad, membranaceous or subchartaceous, bright green and glabrous above, with some hairs on the nerves and along the margins, paler beneath, sometimes somewhat puberulous on the nerves, often with minute glands, the pairs of nerves 5-6; petiole absent or 0-4 mm long, puberulous. *Inflorescence* terminal, cymose, corymbiform, densely glandular and puberulous; primary peduncle (1-) 2-4 (-7) cm long, glandular and puberulous; cymes in anthesis 1-2 cm long and wide with a secondary peduncle of 0.2-1 cm long. *Flowers* bracteate, pedicellate; pedicels glandular and puberulous, 1.5-2 mm long; bracts small and narrow, scarcely 1 mm long. *Calyx* tubular, with 5 minute subequal teeth at the top, becoming 2-lipped in fruit, glandular and puberulous outside, glabrous inside, 1.5-2.5 mm long, accrescent and persistent, spreading under the fruit to about 5 mm in diameter; teeth ± ovate, obtuse, 0.5-1 mm long, nearly as broad at the base; tube 1-1.5 mm long. *Corolla* white or greenish-white, 2-lipped, 4 lobed at the top, glabrous outside or sparsely puberulous on the outside of lobes, villous inside the throat, 3.5-4.5 (-5) mm long; upper lip one-lobed, entire, rounded, 1.5-2 (-2.5) mm in diameter; lower lip 3-lobed, the middle lobe larger than the rest, almost rounded in outline, reflexed, 1.5-2 mm in diameter, the lateral lobes 1-1.5 mm long, 1-1.5 (-1.8) mm broad; tube almost cylindrical, straight, scarcely exceeding the calyx, 1.5-2 mm long, ± 1.5 mm broad at the top. *Stamens* 4, included, inserted in the corolla-tube, more or less didynamous; filaments filiform, glabrous, the anterior pair (1-) 1.2-1.3 mm long, the lateral pair 0.8-1 mm long; anthers ± elliptic-orbicular in outline, 0.4-0.5 mm long, lobes parallel, free and slightly divergent in the lower half. *Ovary* ovoid-globose, glabrous, glandular, ± 1 mm in diameter, 2-celled, each cell 2-ovuled, or by false septum 4-celled each with one ovule; style included, filiform, glabrous, 0.7-1.2 mm long, stigma shortly 2-lobed. *Fruit* obovoid-globose, glabrous, glossy, 5-8 mm long, 4-8 mm in diameter, green when fresh, turning black when mature and dry, fleshy, glossy.

Representative specimens (collections seen: Australian 18, non-Australian 65)

AUSTRALIA: NORTHERN TERRITORY: *Adams 849*, Stuart Hwy, c. 2 miles N of 125 mile peg, 27.i.1964 (BRI, CANB, K, L, NSW, NT); *Adams 2991*, c. 12 km ENE of Oenpelli Mission, 17.ii.1973 (CANB); *Byrnes 1199*, Green Ant Creek East Spring, 28.xi.1968 (DNA, NT); *Byrnes 1244*, Daly River Road, Foster Block, 19.xii.1968 (DNA, L, NT); *Collins BC 134*, Kapalga, 4.xii.1976 (CANB); *Cousins 41*, Miline Rock Pool, 29.xi.1978 (CANB, DNA); *Foelsche s.n.*, McKinley River, Yam Creek, Arnhem Land, -.xii.1882 (K, MEL—syntypes of *Tatea subacaulis* F. Muell.!); *Gardner s.n.*, Katherine, -.i.1953 (PERTH); *Gunn 5*, 12 miles from Stuart Highway along Edith Fall Road, 24.x.1971 (CANB, NT); *Lazarides 7019*, Mt Pleasant, 25 miles S of Adelaide River Township, 5.iii.1964 (CANB, L, NT); *Parker 285*, Tortilla Flats, 21.xi.1973 (CANB, DNA, NT); *Spencer s.n.*, Darwin, 1913 (NSW145252-54); *Tate s.n.*, along the route from Bridge Creek to McKinlay River at twelve mile, Arnhem Land, -.iii.1882 (AD, K—syntypes of *Tatea subacaulis* F. Muell.!).

WESTERN AUSTRALIA: *Gardner 9981*, Kunmunya Air Field near Augustus Waters, 3.vii.1951 (PERTH); *George 14467*, 22 km N of Mitchell Plateau Mining Camp, North Kimberley, 22.iv.1977 (PERTH); *Kenneally 6620*, Mitchell Plateau, West Kimberley, 16.v.1978 (PERTH).

PAPUA NEW GUINEA (16 collections seen): *Barrett NGF 4220*, Mageri near Sogeri, Central Division, Papua, 15.viii.1951 (BRI, CANB, L, LAE); *Brass 6007*, Dagwa, Oriomo River, Western Division, Papua, -.ii-iii.1934 (A, BO, BRI, L, NY); *Craven & Schodde 890*, near Malalaua, Gulf District, Papua, 1.iii.1966 (A, BRI, CANB, K, L, LAE); *Hartley 13081*, below Red Hill, along Lae—Bulolo Road, about 18 miles W of Lae, 3.ix.1964 (A, CANB, K, L); *Henty 16665*, Lake Wanum, subdistrict Lae, 13.iii.1963 (A, BRI, CANB, K, L, LAE); *Hoogland & Macdonald 3451*, c. 3 km inland from Gona, Northern Division, Papua, 27.vii.1953 (A, CANB, L, LAE); *Hoogland 3759*, c. 3 km S of Soputa Crossing, 2.ix.1953 (A, BM, BO, BRI, CANB, K, L, LAE, MEL, US); *Hoogland 4762*, near Madino Village, Milne Bay District, Papua, 16.ix.1954 (A, BM, BRI, CANB, K, L, LAE); *Paijmans 892*, S. coast, NE of Hood Bay, Rigo subdistrict, Papua, 21.vi.1969 (CANB); *Robbins 2221*, near Teringi, Wewak-Maprik Road, 21.viii.1959 (CANB); *Streimann NGF 39074*, Red Hill, Oomsis, Lae subdistrict, 13.vi.1968 (A, BRI, BO, CANB, K, L, LAE, SING, SYD).

INDONESIA: *de Froideville 1946*, Sumba, 1.vi.1950 (BO); *Voogd 2253*, Soemba, 8.xi.1935 (A, BO, L); *Noerkas 245*, van Vuuren Exped. Celebes, Lapankanrae, 20.v.1919 (BO—2 spec.).

PHILIPPINES: *Ramos & Edano B.Sc. 38489*, Maluko and vicinity, Bukidnon sub-province, Mindanao, -vi-vii.1920 (A, BO—2 spec., K, US).

THAILAND: *Kostermans 1267*, Khwae Noi River Basin Exped., 1946, Ku-Jae, about 150 km NW of Kanburi, alt. 100-150 m,. 21.iii-viii.1946 (A, BO).

BURMA: *Dickason 1175*, Kalaw, -.v.1932(A); *Dickason 5943*, Maymyo, -.v.1932(A); *Shaik Mokim s.n.*, Kochin Hills, Upper Burma, -.1897 (Z).

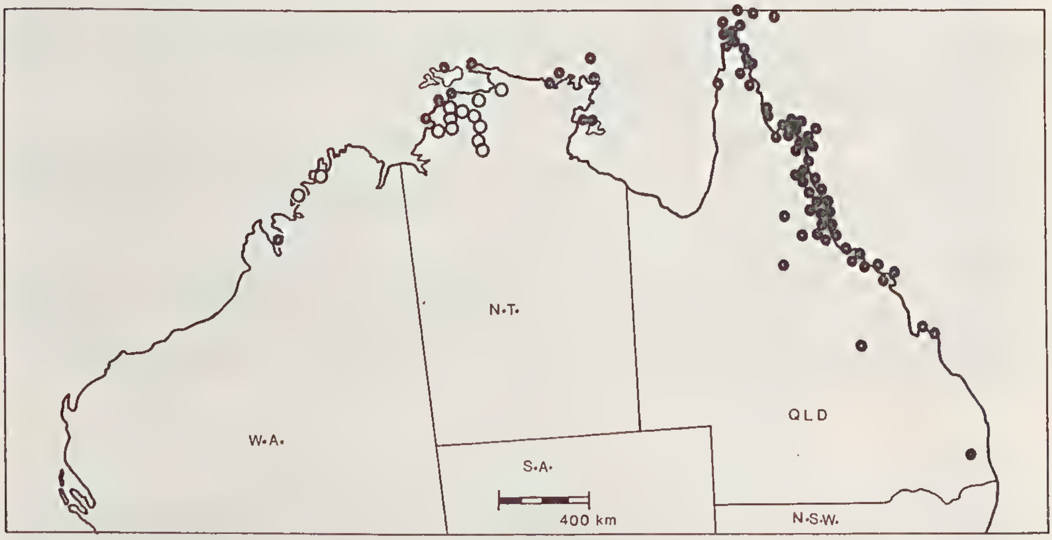
INDIA: *Strachey & Winterbottom s.n.*, near Bagerao, Kumaon, undated (A, BRI, K). *Thompson & Brandis 87*, North Oudh, Jan. 1873(K).

CHINA: *McClure s.n., Cant. Christ. College No. 9262*, on hillside enroute Nga Wan to Yik Tsok Mau, Hainan, 23.iv.1922 (A,K,Z).

Distribution (Map 2)

In Australia, *P. herbacea* is known to occur in the tropics of the Northern Territory and Western Australia. In the Northern Territory, it is known mainly from west of Arnhem Land between 12° and 15° S and between 130° and 134° E. Most localities are to the south and south-east of Darwin along the Stuart Highway. In Western Australia, the distribution is in the western coastal areas of Kimberley.

Collections from overseas have been examined from Papua New Guinea, Indonesia, Indochina, Philippines, Thailand, Burma, India and China. Lam (1919) gave its distribution as being from New Guinea and Luzon, and Merrill (1951) extended its occurrence to Lesser Sunda Islands, Philippine, Hainan, Indochina, Burma and India. According to Moldenke (1983): "This controversial plant appears to spread quite widely from northern Pakistan, Nepal, and Bhutan, through much of India, eastward through Burma, Thailand, and Indo-China to the Philippines, Indonesia, and New Guinea, north to southern China and south to Australia. It is said to be (or to have been) cultivated in India and Ceylon".



Map 2. Distribution of *P. serratifolia* ● *P. herbacea* ○

Comments

Several names referred to herbaceous taxa of the genus are found to be synonymous. A recent example is that of Merrill (1951) who tentatively recognised a conspecific Australian species *Premna acaulis* (F. Muell.) Merr. (= "*Tatea acaulis* F. Muell.") as distinct, but he was by no means certain that this would prove to be the case when it would be possible to make a really critical comparison of representative Asiatic and Australian collections of *P. herbacea* Roxb. and *P. acaulis* (F. Muell.) Merr. Merrill (1951) admitted that he had not seen any specimen of *P. acaulis* from Australia. After examining the type of *P. acaulis*, this species has now been found to be synonymous with *P. herbacea* Roxb.

This species is the only dwarfed and herbaceous *Premna* in Australia, and is known to occur in most parts of Malesia and India. The reason for its dwarf size is attributed by some to its exposure to periodic fires. According to Duthie (1911), this species is "a good example of a plant belonging to a genus mostly represented by trees and shrubs, and which has become permanently dwarfed by continuous exposure to periodical fires". Merrill (1951) endorsed this view and said: "This is what it does in the Philippines where it is found only in open grasslands which are normally burned over each year in the dry season". He further states, that "immediately following a fire, short, practically herbaceous shoots appear which quickly produce leaves and flowers, the internodes being practically non-existent so that the young leaves appear to be in a whorl of four. Soon, however, the shoot becomes lignified and more or less elongated internodes develop. By the time the fruits are mature the plant has the aspect of a greatly dwarfed, simple, or occasionally slightly branched undershrub, up to about 10 cm high". In support of this, van Steenis (pers. commun. 6th Sept. 1983) states that "*Pygmaeopremna* (1 sp.) differs only from *Premna* in ± herbaceous habit and so-called rhizome. It is merely the pyrogenous form of *Premna herbacea* which is outside fire a small subshrub". Such views were also expressed by Parker (1924), and with notes of *P. herbacea* collections from New Guinea.

Merrill (1910) and Lam (1919) described its leaf apex as being acute or shortly acuminate, and margin entire. Amongst the many specimens examined, the leaf-margin at least in the upper half or two-thirds, may be dentate, denticulate, crenate or undulate-crenate, with the basal cuneate part mostly entire.

Moldenke (1959) transferred *Premna angustiflora* H.J. Lam to *Pygmaeopremna* Merr. making a new combination *P. angustiflora* (H.J. Lam) Mold. Subsequently, in his "A Fifth Summary of Verbenaceae etc. 1971", he maintained his new combination, but later in his "A Sixth Summary of Verbenaceae etc. 1980", he reversed his decision by placing it back under the genus *Premna*. According to the protologue, *P. angustiflora* H.J. Lam differs from all known *Pygmaeopremna* by its leaf-petioles being longer, 1.2-5.5 cm long; corolla-tube relatively long and narrow, 0.45-0.55 cm long; stamens exserted; style 0.7-0.8 cm long, which is relatively much longer and obviously exserted. In view of these characters, *P. angustiflora* H.J. Lam is considered a distinct species.

Affinities

P. herbacea does not seem closely related to any single *Premna* species in Australia. It differs from all the rest by its very dwarf size, stem mostly underground with creeping rhizome; leaves sessile, obovate, with basal pair lying flat on ground; stamens and style included. In Australia, the dwarfed *P. herbacea* seems to belong to a section different from tall shrubs or tree species of the genus. Schauer (1847) placed *P. herbacea* in the section *Premnos* Hassk. and the other Australian *Premna* in the section *Gumira* Hassk.

2. **Premna serratifolia** L., Mant. 2 (1771) 253; Spreng., Syst. 2 (1825) 756; Blume, Bijdr. Fl. Ned. In. (1826) 815; Walp., Rep. Bot. Syst. 4 (1845) 96; Schau. in DC., Prod. 11 (1847) 632; Thwaites, Enum. Pl. Zeyl. (1861) 242; F. Muell., Fragm. Phyt. Aust. 6 (1868) 158; Baker, Fl. Maurit. & Seych. (1877) 254; Maxim., Bull. Acad. Sc. St. Petersb. 31 (1887) 79; Trimen, Handb. Fl. Ceylon 3 (1895) 352; Fletcher, Notes Roy. Bot. Gard. Edinb. 19 (1936) 177-178; Fosb., Taxon 2 (1953) 88-89.

Type: *Hermann s.n.*, from Ceylon (LINN holotype, microfiche!).

[*Folium hircinum* Rumph., Herb. Amb. 3 (1743) 208, t. 133].

[*Gumira litorea* Rumph., loc. cit. (1743) 209, t. 134].

[*Cornutioides* L., Fl. Zeyl. (1747) 195]. This is the basis for *Cornutia corymbosa* Burm. f. (1768) and *Premna integrifolia* L. (1771).

Cornutia corymbosa Burm. f., Fl. Ind. (1768) 132, t. 41, f. 1, basionym of *P. corymbosa* (Burm. f.) Merr., Interp. Rumph. Herb. Amb. (1917) 451; Fletcher, Notes Roy. Bot. Gard. Edinb. 19 (1936) 177; Fosb., Taxon 2 (1953) 88-89; Lourt., Taxon 15 (1966) 30.

Type: *Hermann s.n.*, from Ceylon (Institute de France, Paris, n.v.).

Premna integrifolia L., Mant. 2 (1771) 252, *nom. illeg.*, based on the type of *Cornutia corymbosa* Burm. f. (1768); Blume, Bijdr. Fl. Ned. Ind. (1826) 815; Wight, Ic. Pl. Ind. Or. (1849) t. 1469; Miq., Fl. Ind. Bat. 2 (1858) 894; Benth., Fl. Aust. 5 (1870) 59; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 378; C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 574; F. Muell., Sec. Syst. Cens. Aust. Pl. 2 (1889) 173; Briq. in Engl. & Prantl, Pflanzenfam. 4, 3a (1895) 170; F.M. Bail., Qld Fl. 4 (1901) 1176; Comp. Cat. Qld Pl. (1913) 386; Ewart & Davies, Fl. N.-Terr. (1917) 237; H.J. Lam, Verbenac. Malay. Arch. (1919) 140, excl. syn. *P. serratifolia* Blanco; C. Gardner, Enum. Pl. Aust. Occ. 3 (1931) 112; Fosb., Taxon 2 (1953) 88-89; Specht, Rec. Amer.-Aust. Sc. Exped. Arnhem Land, 3 (1958) 292, 470; Beard, Descrip. Cat. W. Aust. Pl. (1965) 93; Chippendale, Proc. Linn. Soc. N.S.W. 96 (1972) 256.

Type: As for *Cornutia corymbosa* Burm. f. (1768).

P. obtusifolia R. Br., Prod. Fl. Nov. Holl. (1810) 512; Schau. in DC., Prod. 11 (1847) 637; Benth., Fl. Aust. 5 (1870) 58; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 378; Qld Woods (1888) 91, (1899) 104; Maiden, Usef. Nat. Pl. Aust. (1889) 591; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; F.M. Bail., Cat. Indig. Natur. Pl. Qld (1890) 35; Qld Fl. 4 (1901) 1175; Comp. Cat. Qld Pl. (1913) 386; Ewart & Davies, Fl. N.-Terr. (1917) 237; Merr., Interpr. Rumph. Herb. Amb. (1917) 451; Enum. Philip. Fl. Pl. 3 (1923) 392; C. White, Proc. Roy. Soc. Qld 34 (1923) 50; Domin, Bibl. Bot. 89 (1929) 556; Fosb., Taxon 2 (1953) 88-89; Specht, Rec. Amer.-Aust. Sc. Exped. Arnhem Land, 3 (1958) 470; Mold., Résumé Verbenac. etc. (1959) 202-207, 210, 221, 257, 275, 297, 298, 337-340, 379; Fifth Summary Verbenac. etc. 1 & 2 (1971) 337-344, 348, 435, 470, 526, 605-612, 709; Chippendale, Proc. Linn. Soc. N.S.W. 96 (1972) 256; Mold., Sixth Summary Verbenac. etc. (1980) 327-340, 409-411.

Type: *R. Brown s.n.*, (J.J. Bennett no. 2324), Prince of Wales Island, Queensland, Australia, xi.1802 (BM 2 syntypes!).

P. corymbosa Rottl. & Willd. in Ges. Naturf. Fr. Berl. Neue Schr. 4 (1803) 187-188; Miq., Fl. Ind. Bat. 2 (1858) 894; C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 573; Trimen, Fl. Ceylon 3 (1895) 352; H.J. Lam, Verbenac. Malay. Arch. (1919) 117, non (Burm. f.) Merr. (1917).

Type: *Rottler s.n.*, between Madras and Tranquebar, Southern India, 1799 (B-W, microfiche!; possible duplicate in J.E. Smith herbarium in LINN).

P. attenuata R. Br., Prod. Fl. Nov. Holl. (1810) 512; Schau. in DC., Prod. 11 (1874) 637.

Type: *R. Brown s.n.*, northern Australia, 1802-1805 (BM, n.v.).

P. media R. Br., Prod. Fl. Nov. Holl. (1810) 512; Schau. in DC., Prod. 11 (1847) 637.

Type: *R. Brown s.n.*, northern Australia, 1802-1805 (BM, n.v.).

P. ovata R. Br., Prod. Fl. Nov. Holl. (1810) 512; Schau. in DC., Prod. 11 (1847) 637.

Type: *R. Brown s.n.*, (J.J. Bennett no. 2325), northern Australia, 1802-1805 (BM!).

P. foetida Reinw. ex Blume, Bijdr. Fl. Ned. Ind. (1826) 816; Schau. in DC., Prod. 11 (1847) 630; Miq., Fl. Ind.

Bat. 2 (1858) 891; Briq. in Engl. & Prantl. Pflanzenfam. 4, 3a (1895) 170; Junell, Symb. Bot. Ups. 4 (1934) 84; Résumé Verbenac. etc. (1959) 195-197, 199, 202, 204, 206, 210, 297, 339; Fifth Summary Verbenac. etc. 1 & 2 (1971) 326, 330, 332, 337-339, 342, 349, 384, 526, 608, 610; Sixth Summary Verbenac. etc. (1980) 327-330, 332, 338, 410.

Type: *Reinwardt s.n.*, in sylvis montosis Nederlandsch Indie, loc. incert. (L, n.v.).

P. spinosa Roxb., Fl. Ind. 3, 2nd edn (1832) 77, *nom. illeg.* Roxburgh cited with the description the validly published *Gumira litorea* Rumph., Herb. Amb. 3 (1743) t. 134.

Type: near Calcutta, India (K, n.v.).

P. sambucina Wall., Cat. no. 1775 (1829), nom. nud.; Schau. in DC., Prod. 11 (1847) 631; S. Moore, J. Linn. Soc. Bot. 45 (1921) 375.

Type: *Wallich 1775*, at Moalmyn, India Orient, 1827 (K, G-DC, microfiche!).

P. gaudichaudii Schau. in DC., Prod. 11 (1847) 631; Briq. in Engl. & Prantl, Pflanzenfam. 4, 3a (1895) 170; Mold., Résumé Verbenac. etc. (1959) 186, 195, 199, 202, 204, 207, 221, 226, 338; Fifth Summary Verbenac. etc. 1 & 2 (1971), 319, 320, 326, 332, 334, 337-341, 343, 376, 608.

Type: *Gaudichaud s.n.*, in Archipelago Mariannae, 1830 (G-DC, microfiche!; duplicates possibly in P & PC).

P. nitida Schumann, Fl. Kaiser Wilh.-Land (1889) 120; Merr., Philip. J. Sc. Bot. 1, Suppl. 1 (1906) 234; Gibbs, Contrib. Pl. New Guinea (1917) 218; Merr., Interpr. Rumph. Herb. Amb. (1917) 451; C. White, Proc. Roy. Soc. Qld 34 (1923) 50; Mold., Résumé Verbenac. etc. (1959) 199, 202-205, 221, 294; Fifth Summary Verbenac. etc. 1 & 2 (1971) 326, 332, 337-341, 519; Sixth Summary Verbenac. etc. (1980) 327-331, 359, 405, 410.

Type: *Hollrung 679*, Augusta Station, Papua New Guinea, August, 1887 (L, n.v.).

Gumira integrifolia (L.) Kuntze, Rev. Gen. Pl. 2 (1891) 507, based on *P. integrifolia* L. (1771).

G. nitida (Schumann) Kuntze, Rev. Gen. Pl. 2 (1891) 508, based on *P. nitida* Schumann (1889).

G. serratifolia (L.) Kuntze, Rev. Gen. Pl. 2 (1891) 507, based on *P. serratifolia* L. (1771).

Premna corymbosa (Burm. f.) Merr., Interpr. Rumph. Herb. Amb. (1917) 450-451, non Rottl. & Willd. (1803), *nom. illeg.*; Fletcher, Notes Roy. Bot. Gard. Edinb. 19 (1936) 177-178; Kew Bull. (1938) 418; A.D.J. Meeuse, Blumea 5 (1942) 72; Fosb., Taxon 2 (1953) 88-89.

Type: *Hermann s.n.*, from Ceylon (Institute de France, Paris, n.v.).

P. integrifolia L. subsp. *truncatolabium* H.J. Lam, Verbenac. Malay. Arch. (1919) 142.

Type: Several syntypes are cited from Indonesia, Philippines and Papua New Guinea. Most of these are preserved in Herb. L (n.v.).

P. abbreviata Miq., Fl. Ind. Bat. 2 (1858) 892.

Type: in fruticetis circa Bataviam (Possibly at U or L, n.v.).

P. laevigata Miq., Fl. Ind. Bat. 2 (1858) 895 ex descr.

Type: Sumatra in Priaman (Possibly at U or L, n.v.).

P. glycycocca F. Muell., Fragm. 3 (1862) 36.

Type: *F. Mueller s.n.*, in locis arenosis insularum, Howick's Group, Aug. 1855 (MEL 582170!).

P. subcordata Turcz., Bull. Soc. Imp. Nat. Mosc. 36 (2) (1863) 216, ex descr.

Type: "Java, Zoll. No. 2742 . . . . Coll. Zeylanica Gardneriana sub. descr. No. 673", n.v.

P. truncata Turcz., Bull. Soc. Imp. Nat. Mosc. 36 (2) (1863) 215, ex descr.

Type: "Terra Canara Indiae orientalis, coll. a Hohenackero editae No. 701", n.v.

P. limbata Benth., Fl. Aust. 5 (1870) 59, syn. nov.; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 378; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; F.M. Bail., Cat. Indig. Natur. Pl. Qld (1890) 35; Qld Fl. 4 (1901) 1176; Comp. Cat. Qld Pl. (1913) 386; Domin, Bibl. Bot. 89 (1929) 556, sub. obs. *P. suavis*; Mold., Résumé Verbenac. etc. (1959) 210; Fifth Summary Verbenac. etc. 1 (1971) 348; Sixth Summary Verbenac. etc. (1980) 338, 410.

Type: *Dallachy s.n.*, Rockingham Bay, Herbert River, 7.xii.1867 (MEL!).

P. integrifolia L. var. *angustiore* C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 574.
Type: *Griffith in Kew Distr. no. 6030*, Malacca (K, n.v.).

P. suavis Domin, Bibl. Bot. 89 (1929) 556, **syn. nov.**; Mold., Résumé Verbenac. etc. (1959) 210; Fifth Summary Verbenac. etc. (1971) 348; Sixth Summary Verbenac. etc. (1980) 338.
Type: *Domin 8126*, Harveys Creek, district Cairn, xii.1909 (PR, syntype!).

P. integrifolia L. var. *obtusifolia* (R. Br.) Péi, Mem. Sc. Soc. China 1, no. 3 (1932) 75, based on *P. obtusifolia* R. Br. (1810).

P. corymbosa (Burm. f.) Merr. var. *angustiore* (C.B. Clarke), Fletcher, Notes Roy. Bot. Gard. Edinb. 19 (1936) 178; Kew Bull. (1938) 419, based on *P. integrifolia* L. var. *angustiore* C.B. Clarke (1885).

P. corymbosa (Burm. f.) Merr. var. *obtusifolia* (R. Br.) Fletcher, Notes Roy. Bot. Gard. Edinb. 19 (1936) 178; Kew Bull. (1938) 419.
Type: As for *P. obtusifolia* R. Br. (1810).

P. obtusifolia R. Br. var. *gaudichaudii* (Schau.) Mold., Phytologia 27 (1973) 69, based on *P. gaudichaudii* Schau. (1847); Sixth Summary Verbenac. etc. (1980) 327-331, 333, 334, 340, 433, 435.

P. obtusifolia R. Br. var. *serratifolia* (L.) Mold., Phytologia 28 (1974) 403, based on *P. serratifolia* L. (1771); Phytologia 31 (1975) 390; Sixth Summary Verbenac. etc. (1980) 395, 433, 434.

Description (Fig. 2 & 3)

Shrub or small tree (1-) 3-6 (-10) m tall. *Stem* brownish-grey with fissured flaky bark, trunk generally about 20 cm or more in diameter; young branches reddish-brown, glabrous. *Leaves*: lamina broadly ovate, obovate or almost orbicular, rounded or cordate at base, broadly obtuse or shortly acuminate at apex, mostly entire, rarely with somewhat serrulate or undulate margin, (4-) 8-15 (-21) cm long, (3-) 5-10 (-16) cm broad, more or less membranous, glabrous, sometimes pubescent along principal veins underneath; petiole somewhat thick, glabrous, (0.5-) 1.5-4 (-7) cm long. *Inflorescence* of terminal, trichotomous, corymbose panicles, with minute pubescence on the young flower-bearing parts, (7-) 10-20 (-25) cm in diameter; primary peduncles thick, glabrous, 2-5 (-7) cm long. *Flowers* greenish-white, almost sessile or shortly pedicellate; pedicels puberulous, 0.5-1 mm long; bracts small and narrow, scarcely 1 mm long. *Calyx* obscurely and irregularly 2-lipped or rather shortly and broadly 3-lobed, upper lip broader than the others and entire or obscurely 3-toothed, lower lip with two obtuse teeth or lobes, 2-2.5 mm long, almost glabrous or obscurely puberulous outside, glabrous inside, spreading open under the fruit but not otherwise enlarged; tube 1-1.5 mm long, about as broad at top; lobes 0.5-1 mm long. *Corolla* greenish-white, somewhat 2-lipped, with distinct 4 lobes at top, glabrous or somewhat puberulous outside, densely villous inside throat, 4-5 mm long; tube almost cylindrical with somewhat broader top end, 2-3 mm long, 1.5-2 mm broad at top; lobes obtuse, almost orbicular in outline, with the anterior or mid-lobe of lower lip larger than the rest, 1.5-2 mm long, almost as broad, with the other lobes 1.3-1.7 mm long, 1.3-1.5 mm broad. *Stamens* exserted, inserted in corolla throat, more or less didynamous; filaments filiform, villous near base, otherwise glabrous, with anterior pair 2-2.5 mm long, with lateral pair 1.5-2 mm long; anthers ± orbicular in outline, with lobes free and divergent in the lower halves, ± 0.5 mm long. *Ovary* more or less globose, glabrous, 1-1.3 mm in diameter; style exserted, filiform, glabrous, 3-4.5 mm long; stigma shortly 2-lobed. *Fruit* obovoid-globose, glabrous, 3-6 mm long, 3-5 mm in diameter, green when fresh, turning black when mature and dry.

Representative specimens (collection seen: Australian 156, non-Australian 147).

AUSTRALIA: QUEENSLAND: (134 collections seen): *Bailey 79*, Somerset Dam, vi.1897 (BRI); *Bailey 138*, Hammond Island, vi.1897 (BRI); *Banks & Solander s.n.*, Cape Grafton, 1770 (BM, 2 spec., probably syntypes of *P. obtusifolia* R. Br.); *Bäuerlen 48*, Thursday Island, 1.vii.1885 (MEL); *Birch S2424*, Damper Creek, S of

Fig. 2. *Premna serratifolia* L. (A-G, *L.J. Webb 2420: CANB; H, B. Hyland 9258*: QRS). A, flowering branch; B, cyme; C, flower; D, flower with calyx and corolla cut open to show androecium and gynoecium; E, 2-lipped calyx-tube; F, ovary; G, transverse section of ovary; H, fruit with persistent calyx.

Cardwell, 6.xii.1965 (JCT); *Brass 19188*, Iron Range, 15.vi.1948 (CANB, L); *R. Brown s.n.*, (J.J. Bennett no. 2324), Prince of Wales Island, xi.1802 (BM, syntype!); *R. Brown s.n.*, (J.J. Bennett no. 2325), loc. cit. 1802-5 (BM, type of *P. ovata*!); *Cameron 20312*, Prince of Wales Island, Big Creek, Torres Strait, 12.ii.1975 (QRS); *Cowley 36*, Thursday Island, undated (BRI); *Cribb s.n.*, Low Island, v.1963 (BRI); *Dallachy s.n.*, Rockingham Bay, Herbert River, 7.xii.1867 (BM, MEL 582176-79, syntypes of *P. limbata*, Benth.); *Domin 8124*, Russell River, i.1910 (PR); *Domin 8126*, Harveys Creek, Dec. 1909 (PR, syntype of *P. suavis* Domin); *Elsol & Stanley 541*, Howick Island, 5.v.1979 (BRI); *Flecker 3316*, Edge of Campbell's Creek, 16.v.1937 (QRS); *Heatwole s.n.*, Hannah Island, near Prince Charlotte Bay, 26.vii.1969 (BRI 149188); *Hyland 3862*, Claudie River, 25.vii.1978 (QRS); *F. Mueller s.n.*, Lord Howick Island, viii.1855 (MEL 582170, holotype of *Premna glycycocca* F. Muell.); *Persieh s.n.*, Endeavour River, 1882 (BRI 267295, MEL 582824); *Scarth-Johnson 915A*, very tip of Cape York Peninsula, 20.x.1979 (BRI); *Smith 12566*, Red Island Point, ca. 25 km SW of Cape York, 28.x.1965 (BRI); *R.L. & A. Specht 240*, Lizard Island, 24.xii.1974 (BRI 202691); *Stoddart 4138*, Newton Island, 5.viii.1973 (BRI); *Stoddart 4928*, Pelican Island, 27.x.1973 (BRI); *Telford 2028*, Forrest Beach, E. of Ingham, 25.v.1970 (CBG); *Webb 957*, Edge Hill, 21.ix.1945 (CANB, JCT).

NORTHERN TERRITORY: (21 collections seen): *Barlow 509*, Rapid Creek, Darwin, 3.i.1963 (JCT, NT); *R. Brown s.n.*, "North Coast", 1802-05 (MEL 582760, MEL 582766, NSW 145256); *Dunlop 3825*, Warangaiyu Lagoon, Elcho Island, 3.vii.1975 (CANB, DNA, NT); *Latz 3278*, Wessell Islands, 28.ix.1972 (CANB, DNA, NT); *Stocker 302*, Karslake Point, Melville Island, i.1966 (NT); *Waddy 459*, Mud Cod Bay, Groate Eylandt, 16.xi.1975 (DNA).

WESTERN AUSTRALIA: *Hughan s.n.*, "Kings Sound", undated (MEL 582820).

PAPUA NEW GUINEA: (116 collections seen): *Craven & Schodde 818*, Apiope, mouth of eastern branch of Purari delta, Gulf District, 14.ii.1966 (A, BRI, CANB, K, L, LAE); *Brass 21922*, Menapi, Cape Vogel Peninsula, Milne Bay District, 15.iv.1953 (CANB).

NEW BRITAIN: (9 collections seen): *Croft NGF 41433*, Kakolan Island off Nantambu Forest Station, 2.vi.1973 (A, BRI, CANB, L, LAE).

NEW IRELAND: (4 collections seen): *Croft & Lelean LAE 65388*, Cape entrance, North Coast, Lavongai, 30.ix.1974 (A, BRI, CANB, E, K, L, LAE, M).

MOLUCCAS: *Pleyte 81*, Ternate, east coast, 6.ix.1951 (BO, BRI).

MALAYSIA: (7 collections seen): *Henderson SING 20233*, Tanjong Suka, Siantan, 3.iv.1928 (BRI, SING).

PHILIPPINES: (8 collections seen): *Merrill 1363*, Palawan, v.1913 (BRI, PNH).

Distribution (Map 2).

In Australia, *P. serratifolia* is chiefly distributed in the tropical areas of Queensland and Northern Territory. In Queensland, most localities are in the coastal parts from Rockhampton northwards to the tip of Cape York Peninsula. It has also been recorded from several off-shore islands of the State. From inland, a few localities are reported on the Atherton Tableland, and some collections are known from the eastern end of Gregory Range and along the upper part of Brisbane River. In Northern Territory, it has been recorded from northern and north-western coastal areas and its off-shore islands. So far, its occurrence deep inland in the Northern Territory or along the coast of the Gulf of Carpentaria is not known. A few localities, however, are reported from Groote Eylandt in the Gulf of Carpentaria. It is possible that this species may be found in the remote tropics of Western Australia, but so far it has been recorded only once from near Kings Sound.

Collections from overseas have been examined from Papua New Guinea, New Britain, New Ireland, Java, the Moluccas, Malaysia, Philippines, Samoa, Fiji, Indochina and Japan. Lam (1919) gave distribution of the species as being from Madagascar, Mauritius, India to Malacca and Thailand, East Bengal, Ceylon, Andamans, Nicobar, Hong Kong, Malaya, Philippines and Polynesia.

In addition to the above localities, Moldenke (1971) recorded it from East Africa, Southern China, Hainan, Taiwan, Ryukyu Archipelago and Melanesia. According to him, the fossilised records of this species were found from "Recent of Mariana Islands".

Comments

The nomenclature and identity of this widespread and very polymorphic species has

been discussed among others by Merrill (1917), Fletcher (1936), Meeuse (1942) and Fosberg (1953). Names frequently employed in this species complex are:- *Premna integrifolia* L., *P. serratifolia* L., *P. corymbosa* Rottl. & Willd., *P. corymbosa* (Burm. f.) Merr. and *Cornutia corymbosa* Burm. f. Of all these, *P. integrifolia* L. is the most widely used name, the type of which was collected by Paul Hermann in Ceylon. It was first described by J. Burman (1737) under the name "Sambucus zeylanica odorata aromatica", and later given by Linnaeus (1747) the single name "Cornutioides". Subsequently, N.L. Burman (1768) for the first time used a binomial for this plant and renamed the Ceylon material *Cornutia corymbosa*.

Following these, Linnaeus (1771) considered the Ceylon material a mixture of more than one taxon and thus split this into two species, *P. integrifolia* and *P. serratifolia*, characterised respectively by their leaf-margin being entire and serrate. He cited under *P. integrifolia* Burman's validly published binomial *Cornutia corymbosa* thus making *P. integrifolia* an illegitimate name (Art. 67, Int. Code Bot. Nom. 1978). Under *P. serratifolia*, Linnaeus cited his invalid single name "Cornutioides Fl. Zeyl. 416". In his opinion, the serrate-leafed plant in Hermann's Ceylon material was different from Burman's *Cornutia corymbosa*. Since the serrate-leaved segregate of the Ceylon material, on which *P. serratifolia* was based, did not involve the entire-leaved type material of *Cornutia corymbosa* Burm. f., it would seem that *P. serratifolia* is a legitimate name. According to Lourteig (1966), the type of *Cornutia corymbosa* Burm. f., on which *P. integrifolia* was based, is preserved at the Institute de France, Paris. I have seen on microfiche the presumed holotype of *P. serratifolia* (LINN) on which Linnaeus wrote not only the name "serratifolia" but also a generic description of the genus *Premna*. Taxonomically, *P. integrifolia* and *P. serratifolia* are the same species, but nomenclaturally they are based on two different types, segregated from Paul Hermann's Ceylon material. That they are synonymous was first pointed out by Schauer (1847) who united these species under the name *P. serratifolia* L. Subsequent authors mostly followed Schauer in uniting the two species, but have used the illegitimate name *P. integrifolia* L. instead of the name *P. serratifolia* L.

In 1803, Rottler & Willdenow described one of Rottler's collection from Madras, India, as a new *Premna* species, *P. corymbosa*. In the protologue, they clearly mentioned this as "Premna corymbosa Nob.", making no reference to *Cornutia corymbosa* Burm. f. In fact, the word "Nob." (i.e. "we" in Latin) clearly shows that they were describing a new species. Rottler contrasted his plant with *P. integrifolia* L. and in a footnote to his paper, Willdenow contrasted three other species of *Premna* with *P. corymbosa*, without mentioning Burman's *Cornutia corymbosa*. Here also, taxonomically *P. corymbosa* Rottl. & Willd. and *Cornutia corymbosa* Burm. f. are identical, but nomenclaturally *P. corymbosa* Rottl. & Willd. was based on a specimen from India and *Cornutia corymbosa* Burm. f. on a specimen from Ceylon. Therefore, the combination of *P. corymbosa* (Merrill, 1917) based on *Cornutia corymbosa* Burm. f. would be a later homonym and illegitimate.

Miquel (1858) used the name *P. corymbosa* Rottl., citing *Cornutia corymbosa* Burm.f. in synonymy. By inference, it may be supposed that he thought Rottler had made a new combination based on *Cornutia corymbosa* Burm. f. In fact, neither Rottler nor Miquel made any combination, the latter simply regarding Burman's name as synonymous with Rottler's.

Confusion about the nomenclature of this complex first arose when Merrill (1917) erroneously assumed that *P. corymbosa* Rottl. & Willd. (1803) was based on *Cornutia corymbosa* Burm. f. He mentioned clearly that "*Premna corymbosa* (Burm. f.) Rottl. & Willd., in Gesell. Nat. Freunde Neue Schr. 4 (1803) 187, 188, is the correct name for the plant that Linnaeus named *Premna integrifolia*". He stressed this point further, that "all

Fig. 3. Range of variation in leaf form and calyces of *Premna serratifolia* L. A, *R. Schodde 2688* (BRI); B, *D.R. Pleyte 81* (BRI); C, *B. Hyland 9692* (QRS); D, *J.A. Elsol 541 & T.D. Stanley s.n.* (BRI); E, *J. McKean B724* (CANB); F, *H.M. Burkill 161 & M. Shah s.n.* (BRI); G, *T. Done s.n.* (BRI 149458); H, *J.R. Croft et al. NGF 41433* (LAE); I, *B. Hyland 3862* (QRS); J, *G.C. Stocker 1347* (QRS); K, *R.G. Robbins 2437* (CANB); L, *M. Ramos PNH 34706* (BRI); M, *L.J. Webb 2420* (CANB); N, *C.T. White 346* (BRI); O, *P. van Royen 5292* (CANB); P, *D. Sayers NGF 18980* (CANB); Q, *J.R. Croft et al. NGF 41386* (LAE).

three", (i.e. *P. integrifolia*, *P. serratifolia* and *P. corymbosa*) "are typified by the same material". This view was later accepted by Fletcher (1936), Meeuse (1942) and some others. It was, however, rejected by Fosberg (1953) who clearly pointed out that *P. corymbosa* Rottl. & Willd. (1803) was described as a new species from India, and it was not based on *Cornutia corymbosa* Burm. f., the type of which came from Ceylon. Nevertheless, Fosberg (1953) did not appreciate the fact that Paul Hermann's Ceylon material, on which *Cornutia corymbosa* Burm. f. was based, had been treated by Linnaeus (1771) as a mixed collection; he considered that both names were based on the type of *Cornutia corymbosa* Burm. f., and were, therefore, illegitimate. The fact that *P. serratifolia* was differently typified and therefore legitimate seems to have been missed by Fosberg (1953), Moldenke (1959, 1971, 1980) and others. They, therefore, accepted *P. obtusifolia* R. Br. (1810) which they considered to be the next available name for this species.

It is quite clear from the above discussion, that *P. serratifolia* L. (1771) is the oldest legitimate name in *Premna* for this complex and, therefore, adopted here.

In Bentham's Flora Australiensis 5 (1870) 58-60, he recorded five *Premna* species from Australia, with *P. limbata* as new. Of these, *P. obtusifolia* R. Br., *P. integrifolia* L. and *P. limbata* Benth. are found to be conspecific with *P. serratifolia* L. Bentham (1870) distinguished these taxa chiefly on the shape of calyx-lobe, leaf-tip and the comparative length of calyx- and corolla-tube. All these characters are too variable to be used in the taxonomy of this complex. As a result of previous use of these and other similarly variable characters, the list of synonymy of the taxon is the largest of any *Premna* species in Australia, and possibly in the genus. There are several more plant names referred to this species, but only a selection are recorded here.

Some authors have described its wood as having a pleasant sandal-like fragrance, but not so aromatic.

Affinities

Amongst Australian *Premna* species, *P. serratifolia* is closely related to *P. dallachyana* Benth. and *P. lignum-vitae* in its leaves being glabrous, sometimes pubescent only on the principal veins beneath, the calyx pubescent outside, the stamens and style exserted and ovary glabrous. However, *P. serratifolia* may readily be identified by its lamina being mostly broadly ovate, obovate or almost orbicular, obtuse, cordate at the base, often dull-brownish when dry, the petiole glabrous and pedicels up to 1 mm long, the corolla greenish-white and fruit always green when fresh. Fruits in *P. dallachyana* and *P. lignum-vitae* are dark purple or reddish-purple when fresh.

Note

In view of limited information about the non-Australian *Premna* species, the affinities of *P. serratifolia* and most other Australian species are not discussed with the non-Australian species.

3. **Premna lignum-vitae** (A. Cunn. ex Schau.) Pieper, Bot. Jahrb. 62, Beibl. 141 (1928) 80; Mold., Résumé Verbenac. etc. (1959) 210, 383-385; Anderson, Trees N.S.W., 4th edn (1968) 255; Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 348, 718, 721; Mold., Sixth Summary Verbenac. etc. (1980) 338; Jacobs & Pickard, Pl. N.S.W. (1981) 209; Baines, Aust. Pl. Gen. part 1 (1981) 303.

Lectotype: *A. Cunningham s.n.*, Brisbane River, Moreton Bay, Queensland, Australia, 2.viii.1829 (G-DC, lectotype designated here!; BM, K, MEL 97941, MEL 583394, MEL 583395,—isolectotypes!).

Vitex lignum-vitae A. Cunn. ex Schau. in DC., Prod. 11 (1847) 692, *basionym*; F. Muell., Fragm. 3 (1862) 58; Benth., Fl. Aust. 5 (1870) 67; F. Muell., Fragm. 9 (1875) 5; Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 379; Qld Woods (1888) 92; Maiden, Useful Nat. Pl. Aust. (1889) 612; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; F.M. Bail., Cat. Indig. & Natur. Pl. (1890) 35; Qld Fl. 4 (1901) 1179; Dixon, Pl. N.S.W. (1906) 235; F.M. Bail., Comp. Cat. Qld Pl. (1913) 386; Maiden & Betche, Cens. N.S.W. Pl. (1916) 176; Anderson, Trees N.S.W. 1st edn (1947) 273; Francis, Aust. Rain-For. Trees (1951) 372, figs 233 & 234.

Type: As for *Premna lignum-vitae* (A. Cunn. ex Schau.) Piper.

Typification

P. lignum-vitae is based on Allan Cunningham's collection from Queensland consisting of at least 5 duplicates. It was identified by him as belonging to *Vitex* and he therefore proposed for it the name *V. lignum-vitae*. The manuscript name was later validly published by Schauer (1847) who cited A. Cunningham's collection from Australia, but did not designate any type. It is, therefore, necessary to select a type for this name. Of the known five syntypes, the one in Herb. G-DC was seen by Schauer and almost certainly used by him in preparing the original description of this species. The specimen is particularly complete and well preserved, and is, therefore, selected here as the lectotype for this species.

Description (Fig. 4)

A tree 4-30 m tall. *Stem* 23-100 cm diameter, outer bark whitish, shallowly longitudinally fissured; young branches rusty-tomentose or rusty-pubescent. *Leaves*: lamina oblong or oval-elliptic, shortly acuminate, narrowed towards base, (4-) 6-10 (-13.5) cm long, (1.5-) 2-4.5 cm broad, somewhat coriaceous, shining green adaxially, paler and glandular abaxially, conspicuously veined, glabrous or with slight pubescence on their midrib underneath, entire, those of barren branches sometimes broadly and unequally lobed or with a few short angles; petiole rusty-tomentose or pubescent, (0.5-) 1-2 cm long. *Inflorescence* of small, loose, axillary cymes, rusty-tomentose, sprinkled with scattered glands; primary peduncle arising from leaf-axil, 5-10 (-15) mm long. *Flowers* dingy-red, distinctly pedicellate; pedicels rusty-tomentose, glandular, 5-12 (-14) mm long; bracts minute, about 1 mm long, rusty-tomentose. *Calyx* persistent, accrescent, tube truncate, (2.5-) 3-4 mm long, about same in diameter at top, densely glandular and rusty-pubescent outside, glabrous inside. *Corolla* purplish-red to pinkish-mauve, 4-lobed, glandular and tomentose outside, glabrous inside except for dense villous inner face of large anterior-lobe and sparsely villous hairy band at level with base of filaments, 9-13 (-15) mm long; tube broad and incurved, twice as long as calyx or more, more or less cylindrical in upper half, narrowed at base, 6.5-10 mm long, 3-5 mm in diameter at top; lobes broadly elliptic-ovate or almost orbicular, with the anterior- (i.e. lower-) lobe larger than others, usually orbicular, 3-4 mm long, 3.5-5 mm broad, with posterior and lateral lobes broadly elliptic-ovate, 2-3 mm long, 2.5-3.5 mm broad at base. *Stamens* exserted, more or less didynamous; filaments slender, glabrous above, villous in lower third, with anterior pair 8-11 mm long, lateral pair 7-10 mm long; anthers ± orbicular in outline, lobes oblong, free and somewhat divergent in lower halves, ± 1 mm long. *Ovary* ± globose, glabrous, 1-2 mm diameter; style exserted, more or less slender, glabrous, (9-) 11-15 mm long; stigma shortly 2-lobed. *Fruit* obovoid-globose, glabrous, (5-) 7-14 (-18) mm long, (5-) 8-15 (-20) mm diameter, pink to paly red or reddish-purple when fresh, turning black on drying.

Representative specimens (52 collections seen)

AUSTRALIA: QUEENSLAND: *J.F. Bailey s.n.*, Bunya Mountains, ix.1897 (BRI 267482-83); *Blake 2115*, Dayboro, 49 km NW of Brisbane, 8.i.1931 (BRI); *Blake 15488*, McPherson Range, Mt Roberts, 26.iii.1945 (BRI); *A. Cunningham s.n.*, Brisbane River, Moreton Bay, 2.viii.1829 (G-DC, lectotype!; K 3 spec!, BM!, MEL 3 spec.! —isolectotypes); *Floyd s.n.*, Kalpower, 3.ix.1949 (LAE 16908). *Grove 106, 113*, Nanango, v.1918 (BRI);

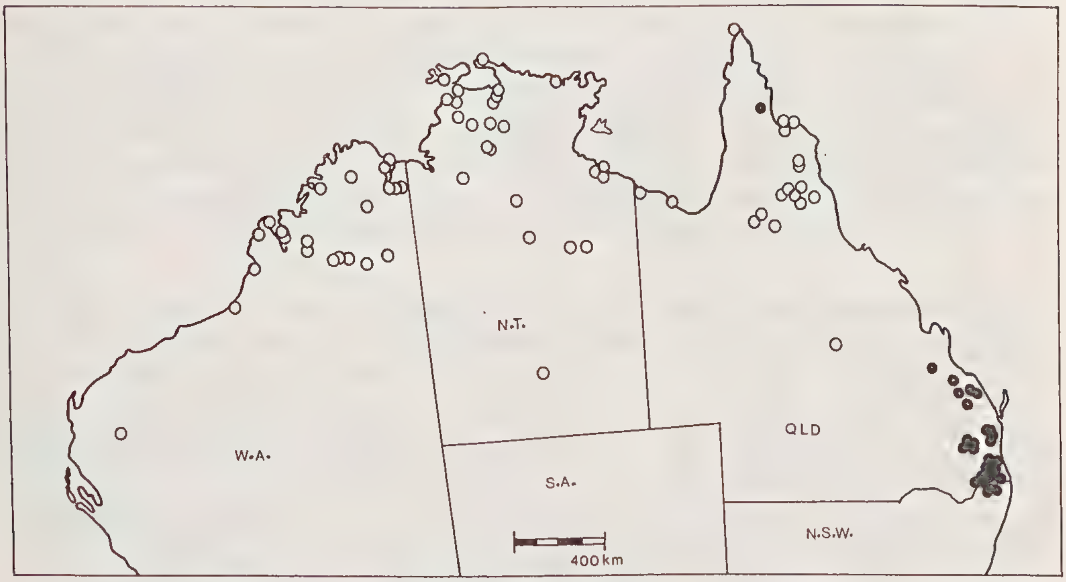
Fig. 4. *Premna lignum-vitae* (A. Cunn. ex Schau.) Pieper. (A-G, *I.R. Telford 3508*: CBG; H, *N. Michael 3024*: BRI). A, flowering branch; B, cyme; C, flower; D, truncate calyx-tube with ovary inside; E, flower with calyx and corolla cut open to show androecium and gynoecium; F, ovary, G, transverse section of ovary; H, fruit with persistent calyx.

Hargreave s.n., Mt Tamborine, ix.1910 (BRI 114802); *Hyland 4296*, Lamington National Park, 3.vii.1976 (LAE, QRS); *Jessop & McDonald 92*, Benarkin State Forest, 4.iv.1978 (BRI); *Jessop & McDonald 101*, S.F. 289 Neumgna ± 16 km W. of Yarraman, 5.iv.1978 (BRI, CANB); *McDonald & Stanton 2361*, S.F. 67 Bulburin, 22.vii.1978 (BRI); *Michael 2155*, Kents Pocket, Fossifern district, 19.i.1935 (BRI); *Michael 3024*, Haly Creek Road near Kingaroy, 29.vii.1947 (BRI, NSW); *Simmonds 379*, Brisbane River, 25.viii.1888 (BRI); *Simmonds s.n.*, Ashgrove, Brisbane, 19.i.1889 (BRI 275462, BRI 267477); *Smith & Webb 3694*, Marburg Range, 27.v.1948 (BRI); *Staer s.n.*, Mt Cooroy, ix.1911 (NSW 145242); *Telford 585*, McPherson Range, track to West Cliff, 18.v.1969 (CBG); *Telford 1644*, Skyring Creek, south of Gympie, 15.v.1970 (CBG); *Telford 3508*, Cotswold, foot of Mt Maroon, 4.x.1973 (CBG); *Webb & Tracy 7370*, McIlwraith Range, NE of Coen, 1962 (BRI); *White 11145*, One Tree Hill Dam near Brisbane, 14.vi.1937 (BRI); *White s.n.*, Woogaroo Creek, x. 1916 (BRI 267472); *White & Francis s.n.*, Bulimba near Brisbane River, viii. 1919 (BRI 267471, NSW 145247); *Williams s.n.*, Canungra, 24.i.1971 (BRI 114024); *Williams & Bird 78058*, Haigslea, ca. 16 km W of Ipswich, 21.v.1978 (BRI).

NEW SOUTH WALES: *Floyd 142*, Mt Dourigan Spur, Limpinwood, 25.xi.1976 (NSW); *Floyd 531*, Sawpit Creek, Roseberry, 2.viii.1977 (NSW).

Distribution (Map 3)

P. lignum-vitae seems to be endemic in Australia where the main distribution is in the south-eastern part of Queensland and in the north-eastern tip of New South Wales. It occurs chiefly in coastal areas and seems to extend westward only to about 160 km inland. Its distribution is restricted between latitude 23° and 29° S, and longitude 150° and 154° E. A majority of collections, however, are known from the rain-forest area of the "MacPherson-Macleay Overlap". Outside this distribution area, only one doubtful collection (without flowers or fruit) from northern Queensland has come from McIlwraith Range in the Cape York Peninsula.



Map 3. Distribution of *P. acuminata* ○ *P. lignum-vitae* ●

Comments

Of all the Australian *Premna* species, *P. lignum-vitae* seems the tallest (up to 30 m), with leaves somewhat coriaceous and glossy on the adaxial surface. It also has the largest flowers and fruits, the latter measuring up to 18 x 20 mm. According to C.T. White (6053: BRI), "the fruit is up to 2 cm diameter and has usually some white specks and bright shiny red all over when ripe".

According to Francis (1951), "the presence of channelled stem is a frequent feature of larger trees of this species. As the timber is more durable than most of the scrub timbers, it is occasionally used for fencing posts. It is suitable for flooring, chisel handles and other small turnery, piano sharps (stained), rules, scantlings". Bailey (1888) states that it has close-grained brown wood with darker streaks suitable for cabinet-work. Maiden (1889) described its wood: hard, close-grained, of blackish colour and a useful timber for cabinet-maker.

The occurrence of *P. lignum-vitae* in New South Wales was first recorded by Bentham (1870) who based it on a sample of "Sydney woods", displayed in a Paris Exhibition during 1855. Subsequently, this species was recorded from this state by F. Mueller (1882, 1889), Maiden (1889) and others without reference to any collections. During present investigations, however, no old collection of *P. lignum-vitae* from New South Wales was found in any Australian herbarium. It is not known on what material the presence of this species in the state was based in the early literature. The only available collections from New South Wales are A.G. Floyd's collections (nos. 142 & 531: NSW) gathered during 1976 and 1977. A large tree of this species grows in the Adelaide Botanic Gardens.

According to collector's field notes, the flowering period seems to be irregular. Both flowers and fruits are often available at various times of the year.

Affinities

P. lignum-vitae is closely allied to *P. dallachyana* in its leaves being glabrous, the lamina cuneate at the base, petiole pubescent, pedicels more than 1 mm long, corolla-tube at least twice as long as the calyx, stamens and style exserted, ovary glabrous and ripe fruits always purplish. Nevertheless, *P. lignum-vitae* may readily be distinguished by its lamina being coriaceous and adaxially shining, the pedicels much longer (5-12 (-14) mm long), corolla tomentose outside, purplish-red or pinkish-mauve and 9-15 mm long, and the fruit pale-red or reddish-purple when ripe, (5-) 8-15 (-20) mm diameter. *P. lignum-vitae* is also related to *P. serratifolia* L. For distinguishing characters see under the latter.

4. **Premna dallachyana** Benth., Fl. Aust. 5 (1870) 59; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 378; Proc. Roy. Soc. Qld 1 (1884) 70; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; F.M. Bail., Cat. Indig. & Natur. Pl. Qld (1890) 35; Qld Fl. 4 (1901) 1176; Comp. Cat. Qld Pl. (1913) 386; Domin, Biblioth. Bot. 89 (1929) 556; Mold., Résumé Verbenac. etc. (1959) 210, 297, 337; Fifth Summary Verbenac. etc. 1 & 2 (1971) 348, 525, 526, 607; Sixth Summary Verbenac. etc. (1980) 338; Baines, Aust. Pl. Gen. Part 1 (1981) 303.

Lectotype: *Dallachy s.n.*, Port Denison, Queensland, Australia, undated (MEL 582175, lectotype designated here!; K, MEL 582172, MEL 582174—isolectotypes!).

P. dallachyana Benth. var. *obtusisepala* Domin, Repert. Spec. Nov. Regni Veg. 12 (1913) 133; Biblioth. Bot. 89 (1929) 556; Mold., Résumé Verbenac. etc. (1959) 210; Fifth Summary Verbenac. etc. 1 (1971) 348; Sixth Summary Verbenac. etc. (1980) 338, syn. nov.

Type: *Dallachy s.n.*, Edgecumbe Bay, Queensland, Australia, undated (MEL 582173!).

P. tateana F.M. Bail., Bot. Bull. Dept. Agric. Qld 13 (1891) 15; Qld Fl. 4 (1901) 1176; Comp. Cat. Qld Pl. (1913)

386, fig. 361; Mold., Résumé Verbenac. etc. (1959) 210; Fifth Summary Verbenac. etc. 1 (1971) 348; Baines, Aust. Pl. Gen. Part 1 (1981) 303, **syn. nov.**

Type: *Barcley-Millar s.n.*, Walsh River, Queensland, Australia, v.1891 (BRI 019365, holotype!; K, isotype!).

P. minor Domin, Biblioth. Bot. 89 (1929) 556; Mold., Résumé Verbenac. etc. (1959) 210; Fifth Summary Verbenac. etc. 1 (1971) 348, **syn. nov.**

Type: *Domin 8129-8132*, near Chilagoe & Mungana, Queensland, Australia, ii.1910 (PR, syntypes!).

Gumira dallachyana (Benth.) Kuntze, Rev. Gen. Pl. 2 (1891) 507, based on *P. dallachyana* Benth. (1870).

Typification

P. dallachyana Benth. is based on two of Dallachy's collections and one of Bowman's, all from northern Queensland. These collections comprise altogether at least eight duplicates which were certainly used by Bentham in preparing the protologue of this species. Since he did not choose any one specimen as a type, it is therefore necessary to select a type for this name. Of all the syntypes, a duplicate of Dallachy's Port Denison collection preserved in Herb. MEL is particularly complete and well preserved and chosen here as the lectotype of this species.

Description (Fig. 5)

A shrub or small tree 2-5 m tall. *Stem* and branches cylindrical, glabrous, bark light-greyish, often shortly longitudinally furrowed and more or less covered with scattered warts. *Leaves*: lamina bright-green, narrowly elliptic or ovate, acuminate, entire, obtuse or more often cuneate towards base, (4.5-) 6-12 (-15) cm long, (1.5-) 2.5-6 (-7.5) cm broad, glabrous, scarcely pubescent along principal veins underneath, usually drying black; petiole pubescent, (1-) 2-4 (-5.5) cm long. *Inflorescence* lax; cymes in corymbose panicle. *Flowers* "white" or "greenish-cream", pedicellate; pedicel pubescent, glandular, 1-2.5 mm long; bracts small and narrow, pubescent. *Calyx* accrescent, obscurely 2-lipped, usually 5-toothed, sometimes 4-toothed, 1.5-2 mm long, puberulous and densely glandular outside when young, later almost glabrous; tube glabrous inside, 1-1.5 mm long; lobes acute or obtuse, not deltoid, ± 0.5 mm long. *Corolla* ± 2-lipped, 4-lobed, glabrous outside, densely villous inside tube and on inner face of lobes, 4-7 mm long; tube ± cylindrical, almost twice as long as calyx, (2.5-) 3-3.5 (-4) mm long, 1-2 mm in diameter; lobes broadly elliptic-oblong or almost oribular, upper lobe comprising posterior lip larger than others. *Stamens* exserted, inserted in corolla throat, ± didynamous; filaments glabrous, filiform, lateral pair (3-) 4-5 mm long, anterior pair (2-) 3-4 mm long; anthers ± orbicular in outline, lobes free and divergent in lower halves, ± 0.5 mm long. *Ovary* globose, glabrous, ± 1 mm diameter; style exserted, filiform, glabrous, 4-6 mm long; stigma 2-lobed. *Fruit* globular, glabrous, verrucose, 3-5 mm diameter, dark purple when ripe, drying black.

Specimens examined

AUSTRALIA: QUEENSLAND: *Barcley-Millar s.n.*, Walsh River, v.1891 (BRI 019365, holotype of *P. tateana* Bial.; K); *Bowan 221*, Fort Cooper, undated (K, MEL 582171, syntypes); *Dallachy s.n.*, Port Denison, undated (MEL 582175, lectotype; K, MEL 582172 & MEL 582174—isolectotypes); *Dallachy s.n.*,Edgecumbe Bay, undated (K, MEL 582173, syntypes of *P. dallachyana* Benth. and var. *obtusisepala* Domin); *Domin 8129, 8130, 8131*, near Chillagoe, ii.1910 (PR, syntypes of *P. minor* Domin); *Domin 8132*, near Mungana, ii.1910 (PR, syntype of *P. minor* Domin); *Dietrich 2826*, Brisbane River, 1863-1865 (PR 2 spec., HBG n.v.); *Godwin C922*, Donna bluff, Chillagoe, v.1980 (BRI); *Michael 1204*, Edgecumbe Bay, undated (BRI); *Persieh 835*, Endeavour River, 1886 (MEL); *Persieh 133*, loc. incert. 1882-1886 (MEL); *Sayer 54*, Russell River, 1886 (MEL); *Webb 646*, Chilagoe, 16.vi.1945 (CANB, JCT); *Webb & Tracy 10910*, Dowlings Hill on Mt Amos road, vi.1973 (BRI 3 spec.).

PAPUA NEW GUINEA: *Hartley 10217*, Markham River valley near Nadzale, Morobe district, 23.v.1962 (CANB); *Henty NGF 11513*, loc. cit. 4.viii.1959 (CANB, LAE); *Pullen 3553*, between Kaiye and Dumana, NW of Hisiu, Kairuke subdistrict, 20.viii.1962 (CANB); *Turner s.n.*, Rigo district, Papua, undated (BRI 267360).

Fig. 5. *Premna dallachyana* Benth. (A-H, *Dallachy s.n.*: MEL 582175; I, *M. Godwin C922*: BRI). A, flowering twig; B, portion of inflorescence; C, flower; D, calyx with five lobes; E, calyx with four lobes; F, flower with calyx and corolla cut open to show androecium and gynoecium; G, ovary; H, transverse section of ovary; I, fruit with persistent calyx.

PHILIPPINES: *Curran 13211*, Island of Corregidor, ix.1911 (BRI); *Ramos 1894*, Province of Batangas, Luzon, viii.1914 (BM, BRI, PNH).

Distribution (Map 4)

In Australia, *P. dallachyana* is found only in Queensland, where it occurs chiefly in the north-eastern coastal region between Cooktown and Port Mackay. Within this area, the major distribution is on the Atherton Tableland and around Edgecumbe Bay. The only other known locality is near the Brisbane River.

Bentham (1870), F. Mueller (1882, 1889), Moldenke (1959, 1971) and other botanists regarded this species as being endemic in Queensland. During present investigations, however, specimens of this species have been examined from Papua New Guinea and the Philippines.

Comments

Baily (1891) distinguished *P. tateana* Bail. from *P. dallachyana* chiefly by its verrucose fruit. Incidentally, this character is not mentioned by Bentham (1870) in the original description of *P. dallachyana* which led Bailey to believe that such a character is not present in this species. According to Bailey (1891), "Bentham would never have escaped detection of verrucose fruit in drawing up the diagnosis of *P. dallachyana*". Apparently, Bailey himself did not examine the type of *P. dallachyana* which also has verrucose fruits. During present investigation, the type of *P. tateana* was found to have fruits similar to those of *P. dallachyana*, as are the leaves and flowers. There seems no justification, therefore, in regarding them as different species. This fruit surface character is more or less variable and has never been used by anyone else in the identification of *Premna* species.

Domin (1929) recognised *P. dallachyana*, *P. minor* Domin and *P. tateana* as being closely related species, but stressed that these should be retained separately. In drawing up

Map 4. Distribution of *P. dallachyana* ▲, *P. hylandiana* ●, *P. odorata* ○.

his new species, *P. minor*, he distinguished it from *P. dallachyana* by its leaves being much shorter, oblong or oblong-elliptic (not ovate), puberulous underneath, inflorescence much more compact and fruiting-calyx at least half the size of the latter. During present investigations, however, the types of *P. minor* and *P. dallachyana* were found to be taxonomically identical. The emphasis on the size and shape of leaves and calyces seems unjustified, for such variation is also found in other species of this genus. Similarly, *P. dallachyana* var. *obtusisepala* Domin is distinguished from the typical variety by its sepals being obtuse and lateral leaves broadly ovate. These characters are not found exclusively in var. *obtusisepala* because such sepals and leaves are also present in the typical variety.

Bentham (1870) placed this species in the group having a 5-toothed calyx, but the type specimens are found to have both 4- and 5-toothed calyces. The 5-toothed calyces are generally more markedly 2-lipped than the 4-toothed ones. In the type material of *P. minor*, a few flowers are found to have 5 stamens.

Bentham (1870), Moldenke (1959, 1971) and others have considered this species as being endemic in Queensland. During present studies, however, some of its collections from Queensland, Papua New Guinea and the Philippines were found to have been identified as *P. nauseosa* Blanco. According to Merrill (1906, 1923), *P. nauseosa* is endemic in the Philippines, but Moldenke (1959, 1971) recorded it from the Archipelago of Ryukyu, the Philippines, the Celebes, Java, Kangean, Sumatra, Timor and Christmas Island. The type of *P. nauseosa* could not be traced for examination, but the specimens identified as this species by other authorities are certainly not different from *P. dallachyana*. According to Merrill (1905), "the types of all Blanco's species have been destroyed. It is certain that Blanco had at least a working herbarium, but unfortunately, after his death, the value of his collection was not recognised. Accordingly, today we are dependent entirely on his imperfect descriptions for the identification of his species". In spite of this shortcoming, Merrill (1918) considered *P. nauseosa* as a valid species. Previously, Schauer (1847) and Miquel (1858) recorded this as a doubtful species, and each gave it a short and imperfect description. In the protologue and all other available descriptions, the leaves of *P. nauseosa* are said to be somewhat cordate. But the leaves in all available collections, identified as *P. nauseosa*, are generally cuneate towards the base. In view of this, the true identity of *P. nauseosa* is somewhat doubtful and, therefore, the name *P. dallachyana* is retained here. If ever *P. nauseosa* and *P. dallachyana* could be shown to be conspecific, then the name *P. nauseosa* (1837) should be adopted.

Most specimens of this species dry black, which is a useful character in distinguishing it from others. According to Bailey (1891), however, "the notice given of the leaves of various *Premnas* drying black is not worthy of note, for if dried quickly they retain a green colour, but if allowed to become damp will turn black". In his view, "the wood of this species is used for making fire-sticks".

Affinities

P. dallachyana is nearest to *P. lignum-vitae* in its lamina being cuneate at the base, the petiole pubescent, pedicels more than 1 mm long and fresh fruit with a purplish tinge. However, *P. dallachyana* may easily be identified by its lamina being chartaceous, dull, turning black when dry, pedicels 1-2.5 mm long, the corolla glabrous outside, greenish-cream, 4-7 mm long, and fruit dark purple when ripe. For its relationship with *P. serratifolia*, see under that species. Bailey (1891) considered its nearest ally to be the Indian species, *P. latifolia* Roxb.

5. **Premna hylandiana** Munir, sp. nov.

Arbor circa 15 m alta. *Caulis* 20-40 cm diametro, cortice fissurato lamelliformis pallido; surculi juvenes tomentoso ferrugineo pilis dendriformibus vel stellatis dense tecti. *Folia* petiolata; lamina ovato-cordata, integra vel late undulata, (8-) 12-20 (-25) cm longa, (5-) 8-15 (-18) cm lata, chartacea, pubescento-tomentosa pilis stellatis abaxillariter. *Inflorescentia* terminalis laxa. *Flores* pedicellata; pedicelli (1.5-) 2-3 (-5) mm longi. *Calycis* tubus fere truncatus, extra sparsim glandulifer et stellato-pubescens. *Corolla* dilute flavida, profunde 4-lobata in parte superiori, extra glabra, lobis dorsaliter sparsim glanduliferis in fauce dense villosa; tubus fere aequans calycem. *Stamina* exserta. *Ovarium* globosum, glabrum, ad apicem glandulosum; stylus exsertus, glaber, filiformis, 3.5-5 mm longus; stigma breviter 2-fida. *Fructus* globosus.

Type: *B. Hyland 10232*, near Lockerbie, lat. 10°, 47′S, long. 142°, 28′E, Queensland, Australia, 1.ii.1980 (QRS, holotype; AD, QRS, 2 spec.—isotypes).

Descriptions (Fig. 6)

At tree ± 15 m tall. *Stem*: trunk 20-40 cm diameter, fluted, with fissured and flaky pale bark; young branches densely clothed with ferruginous pubescent-tomentum of dendriform-stellate hairs. *Leaves*: lamina more or less ovate, cordate at base, shortly narrowed at apex, entire or broadly undulate, (8-) 12-20 (-25) cm long, (5-) 8-15 (-18) cm broad, chartaceous, sparsely pubescent adaxially, densely pubescent-tomentose abaxially with stellate hairs, the first and often second pair of primary veins starting from base of midrib; petiole slender, densely covered with rusty indumentum of stellate hairs, 3.5-6.5 (-8) cm long. *Inflorescence* terminal, somewhat lax, rusty tomentose, 1-2.5 cm long. *Flowers* pedicellate; pedicels ferruginous-pubescent with close stellate hairs, (1.5-) 2-3 (-5) mm long; bracts minute, rusty-pubescent. *Calyx* almost truncate or with 4 short obtuse lobes at top, sparsely glandular and stellate-pubescent outside, glabrous inside; tube cylindrical, 2-3 mm long, 1.5-2 mm diameter at top; lobes short, rounded at top, ± 0.5 mm long, about 1 mm broad at base. *Corolla* cream or pale yellow, deeply 4-lobed in upper part, tubular below, glabrous outside with a few glands on back of lobes, densely villous inside throat, ± 6 mm long; tube cylindrical, almost equal to calyx, 2-3 mm long, ± 1.5 mm diameter; lobes narrowly elliptic-oblong, rounded or obtuse at apex, 3-4 mm long, 1.5-2.3 mm broad, upper lobe somewhat larger than others. *Stamens* exserted, almost equal or anterior pair slightly longer; filaments glabrous, very slender or filiform, anterior pair 3-3.5 mm long, lateral pair 3 mm long; anthers oblong, lobes free and divergent in lower halves, 0.5-1 mm long. *Ovary* globose, glabrous, glandular, ± 1 mm diameter; style exserted, filiform, glabrous, 3.5-5 mm long; stigma minutely 2-fid. *Fruit*: young fruit globular, glabrous, glandular at top; mature fruit not seen.

Specimens examined

AUSTRALIA: QUEENSLAND: *Hyland 10232*, near Lockerbie, 1.ii.1980 (QRS, holotype; AD, QRS 2 spec.); *Hyland 2530 R.F.K.*, near Timber Reserve 9, Lankelly Creek-Pandanus Creek, 9.ix.1971 (QRS); *Hyland 2721 R.F.K.*, Alligator Creek Catchment on the Pascoe River Rd, 16.x.1972 (QRS 3 spec.); *Hyland 2849 R.F.K.*, T.R. 14, Rocky River Catchment, 10.ix.1973 (AD, QRS); *Hyland 3400 R.F.K.*, Lankelly Creek Road, 6.iv.1976 (AD, QRS); *Hyland 3765 R.F.K.*, Claudie River, 20.vii.1978 (QRS 2 spec.).

Distribution (Map 4)

P. hylandiana seems to be endemic in Australia where it is known only from the northern part of Queensland. The presently known distribution is in the northern half of the Cape York Peninsula with most localities to the north of Lat. 14° S along the east coast. Further exploration may reveal its occurrence in other parts of the Peninsula.

Comments

This species is named after Mr B.P.M. Hyland of C.S.I.R.O., Division of Forest Research, Atherton, Queensland, who gathered all six known collection of this species.

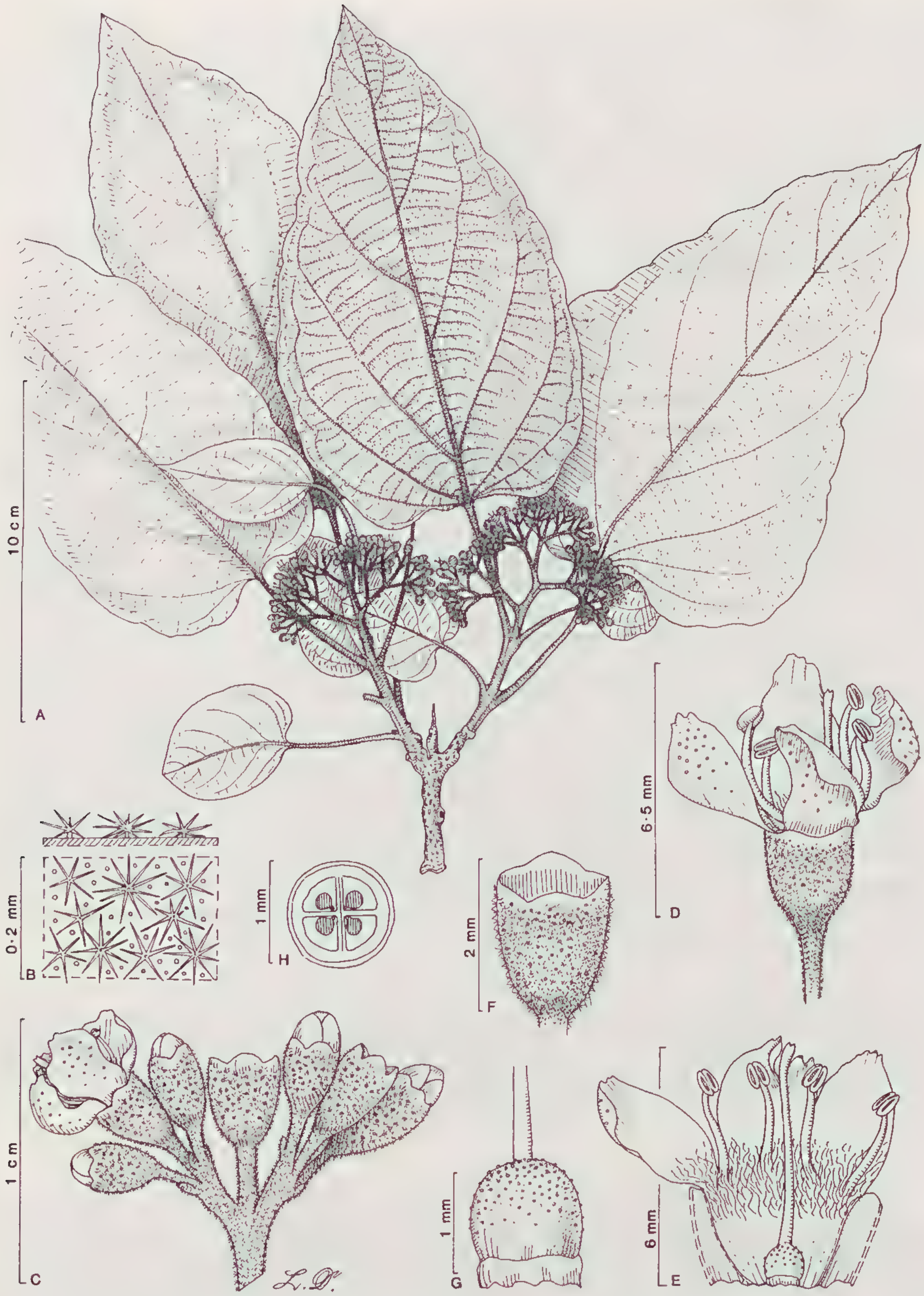


Fig. 6. *Premna hylandiana* Munir, sp. nov. (A-H, *B. Hyland 10232*: QRS, holotype). A, flowering branch; B, enlarged portion of leaf showing stellate hairs on the abaxial surface; C, cyme; D, flower; E, flower with calyx and corolla cut open to show androecium and gynoecium; F, calyx with four short lobes; G, ovary; H, transverse section of ovary.

Of these collections, only *Hyland 10232* has a fully developed inflorescence, which is chosen here as the type. The other collections have well developed leaves but are without any flowers.

Affinities

P. hylandiana has previously been identified as *P. cumingiana* Schau. and is closely related to it in its young shoots and inflorescence being densely clothed with a ferruginous indumentum of dendriform-stellate hairs, the leaves almost identical in shape and size, lamina cordate, entire, stellately tomentose abaxially, sparsely pubescent adaxially, and corolla-tube scarcely exceeding the calyx. Nevertheless, *P. hylandiana* is easily distinguished by its floral bracts being minute, to 0.5 mm long; pedicels much longer, 1.5-3 (-5) mm long, the calyx-tube almost truncate, not 2-lipped, the corolla glabrous outside and lobes more or less similar, not bilabiate, and the ovary glabrous and glandular. In *P. cumingiana*, the bracts are 1-2 mm long, pedicels up to 1 mm long only, calyx-tube distinctly 5-toothed, 2-lipped, the corolla densely pubescent outside and bilabiate, with the ovary and fruit stellately pubescent.

Amongst the other Australian *Premna* species, *P. hylandiana* is closely related to *P. acuminata* R. Br. and *P. odorata* Blanco in its leaves being pubescent-tomentose with a somewhat chartaceous lamina. However, *P. hylandiana* may easily be distinguished by the hairs being dendriform-stellate, the corolla glabrous outside and ovary glandular at the top. The hairs in *P. odorata* and *P. acuminata* are always simple and the corolla pubescent outside.

6. **Premna acuminata** R. Br., Prod. Fl. Nov. Holl. (1810) 512; Schau. in DC., Prod. 11 (1847) 637; F. Muell., Fragm. 3 (1862) 36; Benth., Fl. Aust. 5 (1870) 60; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 378; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; F.M. Bail., Cat. Indig. & Natur. Pl. Qld (1890) 35; Qld Fl. 4 (1901) 1177; Comp. Cat. Qld Pl. (1913) 386; Ewart & Davies, Fl. N. Terr. (1917) 237; Domin, Biblioth. Bot. 89 (1929) 557; Gard., Enum. Pl. Aust. Occ. 3 (1931) 112; Specht in Specht & Mountford, Rec. Amer.-Aust. Sc. Exped. Arnhem Land 3, Bot. & Ecol. (1958) 470; Mold., Résumé Verbenac. etc. (1959) 174, 201, 210, 211, 221, 337, 338; Beard, Descrip. Cat. W. Aust. Pl. (1965) 93; ibid. 2nd edn (1970) 113; Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 292, 337, 348-49, 367, 606, 607; Chipp., Proc. Linn. Soc. N.S.W. 96 (1972) 256; Mold., Sixth Summary Verbenac. etc. (1980) 338; Green, Cens. Vasc. Pl. W. Aust. (1981) 89; Baines, Aust. Pl. Gen. Part 1 (1981) 303.

Lectotype: *R. Brown s.n.*, (J.J. Bennett no. 2328) northern coast of Queensland, loc. incert., Australia, 1802-1805 (BM, lectotype designated here!; BM, MEL—isotypes!).

P. cordata R. Br., Prod. Fl. Nov. Holl. (1810) 512; Schau. in DC., Prod. 11 (1847) 637.

Type: *R. Brown s.n.*, loc. incert, the coast of Queensland and the Northern Territory, Australia, 1802-1805 (BM, K, isotypes).

Gumira acuminata (R. Br.) Kuntze, Rev. Gen. Pl. 2 (1891) 507, based on *P. acuminata* R. Br. (1810); Mold., Phytologia 31 (1975) 398, pro syn.

Typification

P. acuminata R. Br. is based on a Robert Brown collection from the northern coast of Queensland, Australia. It consists of at least three duplicates of which one is preserved in the National Herbarium of Victoria at Melbourne (MEL) and two in the British Museum Natural History (BM), London. One of the syntypes in the BM (J.J. Bennett no. 2328) has a range of leaves and more complete inflorescence, and is selected here as the lectotype for this species.

Description (Fig. 7)

Shrub or small spreading tree 2-5 m tall. *Stem and branches* ± hoary when young, almost glabrous when mature; bark light grey, longitudinally fissured. *Leaves*: lamina dark-green above, ± paler beneath, broadly cordate-ovate, deltoid or almost rhomboidal, acuminate, entire or coarsely and irregularly dentate, (5-) 7-13 (-16) cm long, (3-) 5-9 (-11.5) cm broad, somewhat chartaceous, ± pubescent or tomentose on both sides, the first and often second pair of primary veins starting from base of midrib; petiole slender, pubescent, (3-) 5-7 (-8) cm long. *Inflorescence* of very lax pale green panicles, primary branches trichotomous, remote ones dichotomous, panicle 10-20 cm long, 13-25 (-30) cm broad. *Flowers* greenish-cream, nearly sessile or shortly pedicellate; pedicels pubescent, ± 1 mm long; bracts lanceolate, pubescent ± 1 mm long. *Calyx* mostly 5-toothed, sometimes 4-toothed, ± 2-lipped, pubescent and often somewhat rugose outside, glabrous within, 1.5-2 (-2.5) mm long; tube 1-1.5 mm long; lobes obtuse or of posterior lobe sometimes almost truncate, 0.5-1 mm long, 1-1.5 mm broad at base. *Corolla* reddish or dull brick-red on lobes, pale greenish-cream on tube, 4-lobed, scarcely 2-lipped, pubescent outside, densely villous inside tube, 5-6 (-7) mm long; tube ± cylindrical, almost twice length of calyx, 3-4 mm long, ± 2 mm diameter at top end; lobes broadly elliptic-ovate, shorter than tube, 1.5-2 (-3) mm long, 1.5-2 mm broad, upper one scarcely different from others. *Stamens* exserted, didynamous; filaments glabrous, filiform, anterior pair 2.5-3 mm long, lateral pair 3.5-4 mm long; anthers ± orbicular in outline, lobes free and divergent in lower halves, ± 0.5 mm long. *Ovary* depressed globose, glabrous, ± 1 mm diameter; style exserted, filiform, glabrous, 5-6 mm long; stigma shortly 2-lobed. *Fruit* obovoid or ± globose, glabrous, 4-5 (-6) mm long, 3.5-4 (-5) mm diameter, pale green, drying black.

Representative specimens (91 collections seen)

AUSTRALIA: QUEENSLAND: *Armit 978*, Etheridge River, undated (MEL); *Blake 13550*, Chilagoe, 30.iii.1938 (BRI); *R. Brown s.n.*, north coast, loc. incert., 1802-1805 (BM, lectotype; BM, MEL—isolectotypes); *Dockrill 661*, Stannary Hills, 9.ii.1973 (QRS); *Domin 8133*, Mungana, ii.1910 (PR); *Hyland 5215*, Byerstown Range, 10.vi.1971 (BRI, CANB, LAE, QRS); *Moriarty 1449*, Almaden-Chillagoe Rd., 24.viii.1973 (BRI); *White 1422*, Georgetown, ii.1922 (BRI—2 spec., NSW).

NORTHERN TERRITORY: *Adams 823*, 13 miles S.E. of Katherine, 19.xii.1963 (BRI, CANB, K, L, MEL, NSW, NT, US); *Craven 2343*, Mt Brockman, 21.ii.1973 (A, BRI, CANB, L, LAE, NT); *Flint s.n.*, north of Alice Springs, 1882 (MEL 582837); *Fox 1023*, Smith Point, 27.xi.1975 (DNA); *Hulls s.n.*, Escape Cliff, undated (MEL 582743); *Lazarides 6846*, Katherine River, Katherine Research Station, 15.iii.1963 (CANB, NT); *Lazarides 7955*, 7 miles W of Mt Gilruth, 2.iii.1973 (BRI, CANB, NT); *Maconochie 2294*, 17 km W Stuart Highway along Top Spring Road, 10.i.1978 (CANB, NT); *McDoual Stuart Exped. s.n.*, North Australia loc. incert., 1861-62 (MEL 582752); *McKee 8335*, Humpty Doo, Darwin area, 10.ii.1961 (L, NSW, NT); *Martensz & Schodde AE 365*, vicinity of El Sharana, 16.i.1973 (BRI, CANB, DNA, NT); *Martensz & Schodde AE777*, Cannon Hill turnoff, Oenpelli Rd, 8.ii.1973 (BRI, CANB, DNA, NSW, NT); *F. Mueller s.n.*, Victoria River, x.1855, (MEL 582754, MEL 582753); *Parker 324*, Tortilla Flats, 17.i.1974 (DNA, MO); *Perry 1593*, 20 miles ENE of Rockhampton Downs Station, 4.vii.1948 (BRI—2 spec., CANB, NT); *Tate 33*, Adelaide River, 1882 (MEL 582737); *Travers 9063*, Wearyan River, Manangoora, 2.vi.1962 (NT); *Webb & Tracy 12260*, western gully of Mt Douglas, v.1978 (BRI).

WESTERN AUSTRALIA: *Byrnes 1822*, Reynolds Creek, 10.iii.1970 (DNA, MEL, NT); *Fitzgerald 527*, near junction of Lennard & Barker Rivers, v.1905 (PERTH); *A. Forrest s.n.*, 1879 (MEL 582840); *George 12275*, Prince Regent River Reserve, 14.viii.1974 (PERTH); *Hartley 14585*, Vicinity of Faith Hill, Cape Dussejour, 14.iii.1978 (CANB, PERTH); *Hughan s.n.*, Beagle Bay, 1869 (MEL 582821-22); *Kenneally 4407*, Carson River at junction with Woorakin Creek, Drysdale River National Park, 17.viii.1975 (PERTH); *Royce 7037*, Brooking Spring, 18.v.1962 (PERTH); *Rust 62*, Karunjie Kimberley Research Station, 7.iii.1950 (CANB); *Tepper 532*, Roebuck Bay, i.1890 (PERTH); *Vasek 690317-10*, West Edge Derby, 17.iii.1969 (CANB); *Walden s.n.*, Kununurra, 16.iii.1972 (PERTH).

Distribution (Map 3)

P. acuminata seems to be endemic in Australia where it is known to occur in the tropics of Queensland, Northern Territory and Western Australia. In Queensland, it is

Fig. 7. *Premna acuminata* R. Br. (A-H, *L.A. Craven 3778*: CANB; I, *L.A. Craven 2343*: CANB). A, flowering branch; B, cyme; C, flower; D, flower with calyx and corolla cut open to show androecium and gynoecium; E, calyx with four lobes; F, calyx with five lobes; G, ovary; H, transverse section of ovary; I, fruit with persistent calyx.

known mainly from Cape York Peninsula, and Sweers Island in the Gulf of Carpentaria. The northern-most locality is on Thursday Island in the Torres Strait and the southern-most near Dunrobin west of Clermont. The only other place of its occurrence in Queensland is along Settlement Creek near the border of Northern Territory.

In Northern Territory, the main distribution is in Arnhem Land with a few scattered localities on the Barkley Tableland. Some collections are also known from the Sir Edward Pellew Group of islands in the Gulf of Carpentaria. One odd collection, reportedly from north of Alice Springs, is probably from the Barkley Tableland region. According to present investigations, the southern-most locality of this species is to the north of 19° S latitude. There is no other collection to confirm its occurrence anywhere south of Tennant Creek or the Barkley Highway.

Distribution in Western Australia is chiefly in the Northern botanical Province of Beard (1970). The only locality outside is reported from about 240 km south-east of Onslow near Reynolds Creek. This locality being so far away from the main distribution area needs further investigation to confirm the presence of this species there.

Moldenke (1959, 1971) recorded this species from Papua and Hainan, but so far no *P. acuminata* collection is known to me from these areas.

Comments

This species is readily distinguished by its long, acuminate, pubescent foliage and the largest and most loose inflorescence of all Australian *Premna.*

Notes with D.F. Thomson's collection no. 23 (BRI) and Reeve & Baku's collection no. 137 (CANB) state that the wood of this species is used for firesticks by aborigines.

Bentham (1870) cited under this species a collection from McDoual Stuart's Expedition into northern Australia. It consists of two herbarium sheets numbered MEL 582751 and MEL 582752. The former (MEL 582751) comprises parts of only two damaged leaves which are glabrous, about 17 x 16 cm and more or less circular in outline. These characters do not agree with the leaves of *P. acuminata.* This herbarium sheet is, therefore, being excluded from this species. The other herbarium sheet, MEL 582752, is without an inflorescence, but its leaves match well with the foliage of other *P. acuminata* collections.

The hand-written label no. "397" of an unknown collector on the herbarium sheet MEL 582734 seems to agree with that on the label of MEL 582842. The former was collected during 1886 and latter in 1884.

According to Moldenke (1971), this species is cultivated in California and Java. Previously, Dakkus (1957) listed it in the catalogue of plant species cultivated in the Botanic Gardens, Bogor, Java.

Affinities

P. acuminata is closely related to *P. odorata* Blanco in its leaves being pubescent with simple hairs, the flowers subsessile, calyx and corolla pubescent outside, stamens and style exserted, and ovary glabrous without glands. Nevertheless, *P. aeuminata* may readily be distinguished by its Poplar-like leaves with lamina much acuminate, cordate-ovate, deltoid or almost rhomboidal in profile, with entire or coarsely and irregularly dentate margins, the inflorescence is very lax, 15-25 (-30) cm broad, the corolla reddish or brick-red, 5-7 mm long and the style 5-6 mm long. In *P. odorata*, the leaves are never deltoid or rhomboidal, the inflorescence is not lax, the corolla greenish- or pinkish-white and style 3-5 mm long. *P. acuminata* is also related to *P. hylandiana.* For details see under the latter.

7. **Premna odorata** Blanco, Fl. Filip. edn 1 (1837) 488; ibid. edn 2 (1845) 341; ibid. edn 3, 2 (1878) 268; Walp., Rep. Bot. Syst. 4 (1845) 96; Schau. in DC., Prod. 11 (1847) 638; Miq., Fl. Ind. Bat. 2 (1858) 900; Merr., Rev. Sp. Blanco Fl. Filip. (1905) 68; Philip. J. Sc. 1 (1906) Suppl. 121, 123; Fl. Manila (1912) 405; Sp. Blancoanae (1918) 331; Enum. Philip. Fl. Pl. 3 (1923) 392; Hallier f., Meded. Rijks-Herb. Leid. no. 37 (1918) 39; Mold., Résumé Verbenac. etc. (1959) 172, 185, 188, 190, 195, 199, 202, 221, 337-340; Fifth Summary Verbenac. etc. 1 & 2 (1971) 278, 281, 283, 290, 297, 302, 306, 311, 318, 326, 330, 333, 337, 412, 607-611, 972.

Neotype: *J. Tadena PNH 9602*, Mt Makiling, Laguna Prov. 28.ii.1949 (BRI 267491, neotype; PNH, isoneotype).

P. serratifolia auct. non. L.: Blanco, Fl. Filip. edn 2 (1845) 342; ibid. edn 3, 2 (1878) 269; Merr., Rev. Sp. Blanco Fl. Filip. (1905) 68.

Type: *Blanco s.n.*, Luzon, Philippines (Location unknown).

P. vestita Schau. in DC., Prod. 11 (1847) 631; Miq., Fl. Ind. Bat. 2 (1858) 292; F.-Vill., Novis App. (1880) 159; Merr., Dic. Pl. Philip. (1903) 178; For. Bur. Bull. no. 1 (1903) 51.

Type: *Cuming 599*, in insulis Philippinis (B, n.v.).

P. obtusifolia R. Br. var. *velutina* Benth., Fl. Aust. 5 (1870) 59, **syn. nov.**, F.M. Bail., Synop. Qld Fl. (1883) 378; Cat. Pl. Qld (1890) 35; Qld Fl. 4 (1901) 1176; Comp. Cat. Qld Pl. (1913) 386; Mold., Résumé Verbenac. etc. (1959) 427; Fifth Summary Verbenac. etc. 1 & 2 (1971) 348, 606, 609.

Type: *Dallachy s.n.*, Rockingham Bay, Queensland, undated (BM, K, MEL 582180, MEL 582810, syntypes!).

P. foetida auct. non Reinw. ex Blume: F.-Vill., Novis App. (1877) 159.

P. tomentosa auct. non Willd.: F.-Vill., Novis App. (1877) 159.

Gumira odorata (Blanco) Kuntze, Rev. Gen. Pl. 2 (1891) 508, **syn. nov.**, based on *P. odorata* Blanco.

Premna curranii H.J. Lam, Verbenac. Malay. Arch. (1919) 116; Bull. Jard. Bot. Buitenz. III, 3 (1921) 37; Mold., Fifth Summary Verbenac. etc. 2 (1971) 607, pro syn.

Type: *Curran 19022*, Manila, Philippines (n.v., probably at L or PNH).

P. oblongata Miq. var. *puberula* H.J. Lam, Verbenac. Malay, Arch. (1919) 217; Mold., Résumé Verbenac. etc. (1959) 338, pro syn. *P. odorata* Blanco; Fifth Summary Verbenac. etc. 2 (1971) 609, pro syn.

Type: *Elmer 9388*, Lucban, Tayabas Prov., Luzon, Philippines (L, PNH).

P. pubescens Blume var. *odorata* (Blanco) H.J. Lam, Verbenac. Malay. Arch. (1919) 153; Bull. Jard. Bot. Buitenz. III, 3 (1921) 44, excl. syn. *P. subscandens* Merr.; Mold., Résumé Verbenac. etc. (1959) 339, pro syn.; Fifth Summary Verbenac. etc. 2 (1971) 610, pro syn.

Type: As for *P. odorata* Blanco.

P. benthamiana Domin, Bibl. Bot. 89 (1929) 556; Mold., Résumé Verbenac. etc. (1959) 210; Fifth Summary Verbenac. etc. 2 (1971) 606, pro syn.

Type: *A. Dietrich 2628*, Port Mackay, Queensland, 1863-1865 (MEL, PR syntypes!).

P. inaequilateralis E. Beer & H.J. Lam, Blumea 2 (1936) 226, **syn. nov.**; Mold., Résumé Verbenac. etc. (1959) 202; Fifth Summary Verbenac. etc. 1 (1971) 337.

Type: *L.J. Brass 5536*, Mafulu, Central Division, Papua, ix.-xi.1933 (BRI, isotype!; L).

Typification

P. odorata was described by Blanco (1837) from the island of Luzon in the Philippines. At the end of the protologue, he mentioned a few native names but did not cite any collection, collector's name or number. Enquiries for the type have been made in Herb. B, BM, FI, G, K, L, LAE, MA, PNH, SING and U, but none seems to have the specimen. It has not been cited by any botanist dealing with the Verbenaceae of the Philippines region.

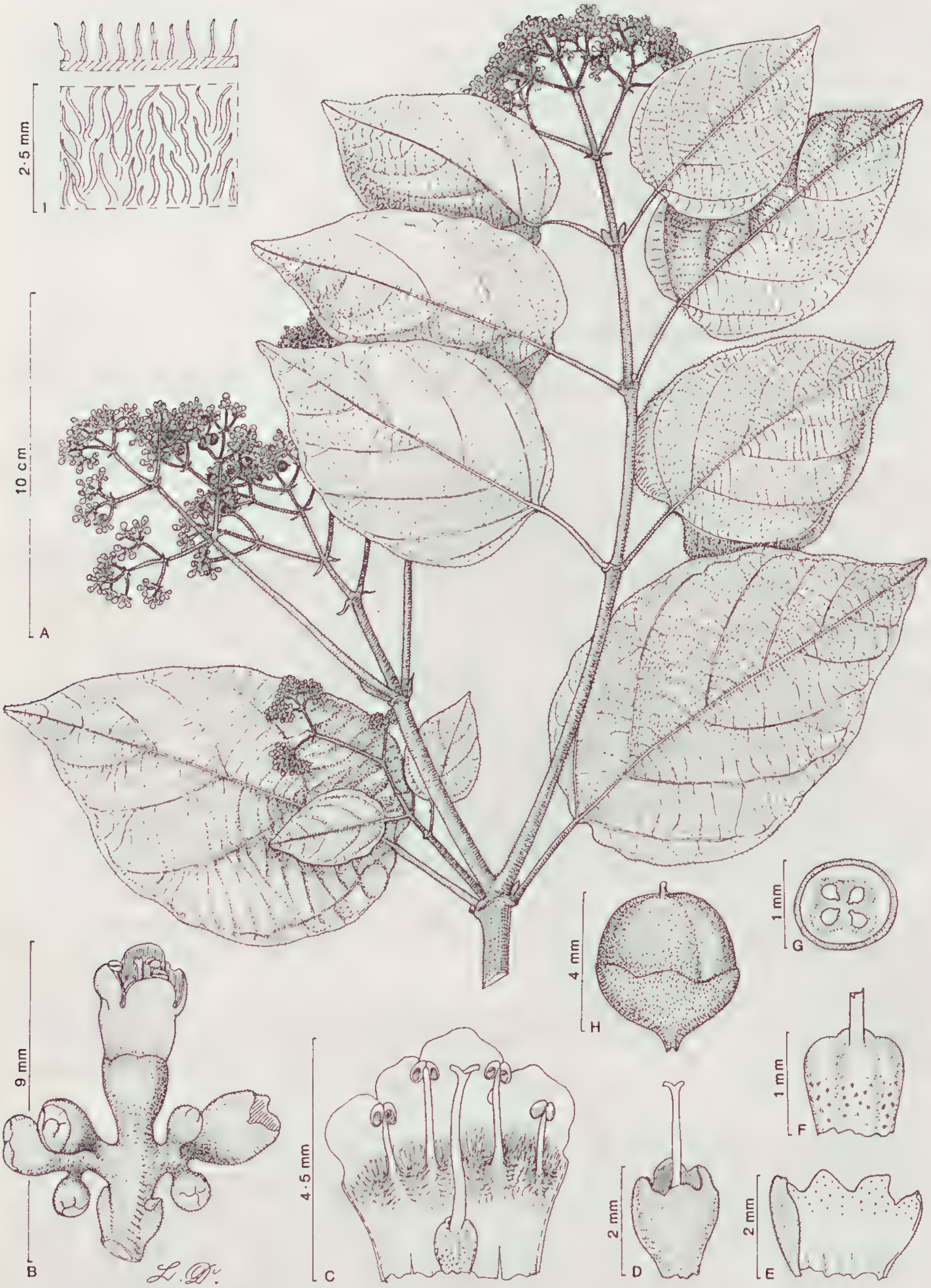


Fig. 8. *Premna odorata* Blanco (A-I, *R. Schodde 2922*: CANB). A, flowering branch; B, cyme; C, flower cut open showing androecium and gynoecium; D, calyx enclosing ovary with exserted style; E, calyx cut open vertically showing glabrous inside; F, ovary; G, transverse section of ovary; H, fruit with persistent calyx; I, enlarged portion of leaf showing simple hairs on abaxial surface.

According to Merrill (1905), "the types of all Blanco's species have been destroyed", therefore, it became necessary to select a neotype for this species.

Of all the authentically named *P. odorata* specimens from the Philippines the collection by J. Tadena (No. PNH 9602) is very typical of this species. It came from the type area, conforms in all details with Blanco's description, and is, therefore, designated here as the neotype.

Description (Fig. 8)

Shrub or small tree (2.5-) 3-10 (-12) m high. *Stem* 15-25 (-30) cm diameter; bark finely flaky fissured; branchlets densely brownish-pubescent; hairs simple. *Leaves*: lamina ovate or ovate-rotundate, sometimes ovate-lanceolate, base rounded, subcordate or oblique, sometimes subcuneate, apex cuspidate-acuminate or ± shortly acuminate, margins entire or sometimes somewhat serrulate-denticulate in upper half, (5-) 6.5-16 (-20) cm long, 4-10 (-13.5) cm broad, membranous or subchartaceous, pubescent all over, especially beneath and on nerves, sometimes glabrate except on nerves, dark-green above, pale or yellowish-green below; hairs simple; pairs of nerves 3-7, often the lowest two pairs starting from base; petiole pubescent, (1-) 2-6 (-7) cm long. *Inflorescence* of many-flowered corymbose panicle, pubescent, 5.5–13 (-15) cm long, 4-15 (-20) cm diameter; primary peduncles 1-4 (-5) cm long, pubescent. *Flowers* almost sessile or shortly pedicellate; pedicels pubescent, 0.5-1.5 mm long; bracts linear, pubescent. *Calyx* rather variable, usually 2-lipped, upper lip entire or shortly 3-lobed, lower with 2 rounded lobes, sometimes lobes subacute, whole calyx 1.5-2.5 mm long, densely pubescent outside, glabrous inside, spreading open under fruit but otherwise not accrescent; tube 1-1.5 mm long, 1-1.5 mm diameter at top; lobes 0.5-1 mm long. *Corolla* "greenish-white" or "pinkish-white", 2-lipped, upper half of tube outside of lobes somewhat pubescent, glabrescent later, densely villous within upper half of tube, 3.5-5.5 mm long; tube almost cylindrical, nearly twice as long as calyx, 2-3 mm long, 1.5-2 mm broad at top; upper lip entire, lower 3-lobed, midlobe of lower lip larger, ovate-orbicular in outline, obtuse, 1.5-2 mm long, nearly as broad, glabrous, lateral lobes 1-1.5 mm long, 1-1.2 (-1.5) mm broad, glabrous. *Stamens* exserted, inserted in corolla throat, subdidyamous; filaments filiform, glabrous with a few villous hairs near base, anterior pair 1.5-3 mm long, lateral pair 1-2 mm long; anthers ± orbicular in outline, lobes free and divergent in lower halves, about 0.5 mm long. *Ovary* ± globose, glabrous, ± 1 mm diameter; style exserted, filiform, glabrous, 3-5 mm long, stigma shortly 2-fid. *Fruit* obovoid, glabrous, 3-5 mm long, 3-4.5 mm diameter above middle, green and smooth when fresh, black when dry, sometimes somewhat verrucose.

Representative specimens (collection seen: Australian 18; non-Australian 32)

AUSTRALIA: QUEENSLAND: (10 collections seen): *Dallachy s.n.*, Rockingham Bay, undated (K, MEL 582180, MEL 582810, syntypes of *P. obtusifolia* R. Br. var. *velutina* Benth.); *Dietrich 2628*, Port Mackay, 1863-1865 (MEL, PR—syntypes of *P. benthamiana* Domin).; *Flecker 14250*, Helenvale, 25.vii.1952 (QRS); *Persieh 817*, Endeavour River, undated (MEL); *Thorsborne 14*, North bank of Dalrymple Creek, 5 & 10 km from Dalrymple Gap, 16.ii.1975 (BRI); *White 1839*, Kuranda, 28.ii.1922 (BRI 267296-97).

NORTHERN TERRITORY: (8 collections seen): *Byrnes 294*, Rapid Creek, 11.ii.1968 (AD, NT); *Dunlop 3995*, Poonali Beach, Melville Island, 18.xii.1975 (DNA, NT); *Maconochie 538*, Rapid Creek, 12.ii.1968 (BRI—2 spec., NT); *McKean B944*, Myilly Point, Darwin, 9.ii.1973 (BRI, CANB, DNA, NT); *Specht 355*, Hempel Bay, Groote Eylandt, 4.v.1948 (AD, BRI, L, LAE, MEL); *Story 8410*, 250 km ENE of Darwin, 26.vi.1978 (CANB); *Waddy 622*, Bardalumba, Groote Eylandt, 11.i.1977 (DNA).

PAPUA NEW GUINEA: (16 collections seen): *Brass 5536*, Mafulu, Central Division, ix.-xi.1933 (BRI, isotype of *P. inaequilateralis* Beer & H.J. Lam); *Carr 11305*, Kanosia, 12.ii.1935 (CANB, 2 spec.); *Craven & Schodde 690*, near Kerema, Gulf District, Papua, 10.i.1966 (CANB, L, LAE); *Henty NGF 14392*, Lake Wanum, 22.i.1962 (CANB 2 spec.); *Millar & Wandenberg NGF 35220*, near Mission Baiyer River, 30.ix.1967 (BRI, CANB, L); *Pullen 1344*, Ningererp, Bairrh, 20.vii.1959 (CANB 2 spec., A, L, LAE); *Ridsdale NGF 30395*, Kilenge, West New Britain, 14.xii.1966 (LAE); *Schodde 2922*, ca. 3 miles W. of Sogeri, Central District, Papua, 6.ix.1962 (A, BO, BR, BRI, CANB 2 spec., K, L, LAE, US); *Schodde & Craven 4686*, west bank of Tauri River, 2 miles S. of junction

with Kapu River, 15.iii.1966 (A, BRI, CANB, K, L, LAE, US); *White 608 & 609*, Mafulu, Papua, vii.-viii.1918 (BRI, 2 spec.); *White, Dadswell & Smith NGF 1624*, Morobe District, Yalu area, vii.1944 (BRI, LAE).

PHILIPPINES: (16 collections seen): *Alvarez PNH 22378*, Prov. of Nueva Ecija, Luzone, ii.1911 (BRI, PNH); *Celestino PNH 4433*, Mt Pulong, Mountain Province, Luzon, iii.1948 (PNH); *Curran PNH 17683*, Mt Aryat, Prov. of Pampanga, Luzon, iii.1910 (BM, BRI); *Esteve PNH 35382*, Mt Makiling, Laguna Prov., Luzon., 17.ii.1955 (CANB); *Federico PNH 40361*, loc. cit. 17.ii.1955 (PNH); *Guinto PNH 41334*, Mt Makiling, Laguna Prov., Luzon, 5.x.1954 (PNH); *Madulid & Hamoy 886*, National Forage Park, Damortis, La Union, 24.v.1972 (PNH); *Tadena PNH 9602*, Mt Makiling, Laguna Prov., 28.ii.1949 (BRI, neotype; PNH); *Villaflor PNH 37536*, Infanta, Quezon Prov., Luzon, i.1955 (PNH); *Vidal 846, 847*, Unisan, Pr. Tayabas, undated (MA).

Distribution (Map 4)

In Australia, *P. odorata* is chiefly known from the tropical parts of Queensland and Northern Territory. In Queensland, the distribution is mainly in the coastal parts from Mackay northwards to Cooktown. In several places the distribution overlaps with that of *P. serratifolia*. In Northern Territory, it has been recorded from around Darwin and Oenpelli Mission areas. From off-shore parts of the State, one collection has come from Melville Island and two from Groote Eylandt. So far, it has not been recorded from any area far inland.

From overseas, collections have been examined from Papua New Guinea, New Britain, Java and the Philippines. Lam (1919) gave its distribution as being from Java, Celebes and Philippines. In addition to the above distribution, Moldenke (1971) recorded it from Florida (U.S.A.), Nepal, southern China, Taiwan, Japan, southern India, upper Burma, Thailand, Indochina, Malaya, Sumatra, the Moluccas and Timor. The above record from Florida (U.S.A.) is very much outside the distribution range of this species and it may have come from a cultivated plant. According to Moldenke (1971), this species is under cultivation in Florida, India, Java, Philippines and Trinidad.

Comments

P. odorata has often been mistaken as *P. pubescens* Blume because both of them have similar looking pubescent leaves and inflorescence. The types of these species are not to be found in any major herbarium in the Malesian region or Europe. Their original descriptions are not very detailed, and the current identifications of these species seem to be based chiefly on their published descriptions. In some institutions they are regarded as one and the same species, while in others they are kept separate. For instance, in Herb. K, all material (about 20 sheets) referred to *P. pubescens* and *P. odorata* is filed under the name *P. pubescens*, while in the BM, virtually all material (10 sheets) is under the name *P. odorata*. In Herb. L, however, both species are filed separately. Fernandez-Villar (1880) reduced *P. odorata* to the synonymy of *P. pubescens*, and Lam (1919) regarded it as a variety of the latter. Both species are rather variable but the type of indumentum is similar, except for degrees in density which apparently overlap. For easy identification of these closely related species, some distinguishing characters are cited here.

P. pubescens (As described in the literature)	***P. odorata***
(1) Liana or climbing shrub	(1) Shrub or small tree
(2) Leaves usually serrate-dentate-crenate in the upper part, rarely entire, somewhat glandular beneath	(2) Leaves usually entire in the upper part, occasionally shallowly crenate, not glandular beneath
(3) Calyx pubescent and glandular outside	(3) Calyx pubescent outside but without glands
(4) Corolla-tube pubescent and glandular outside; lobes pubescent outside and on the inside	(4) Corolla-tube pubescent outside but becoming glabrescent later, not glandular, lobes glabrous all over
(5) Ovary glabrous with some scattered hairs and glands at the top	(5) Ovary glabrous, without hairs or glands at the top
(6) Fruit "3-10 mm diameter" (usually 3-6 mm diameter)	(6) Fruit 3-4.5 mm diameter

The largest fruit (up to 1 cm diam.) recorded in the literature for *P. pubescens* is not matched in any collection. In the specimens examined, I have seen fruits only up to 6 x 6 mm.

After examining the isotype of *P. inaequilateralis* Beer & H.J. Lam and syntypes of *P. obtusifolia* R. Br. var. *velutina* Benth., both taxa are found to be conspecific with *P. odorata*, and are, therefore, recorded here as new synonyms. In the protologue of *P. inaequilateralis*, the species was distinguished from other species chiefly by its oblique leaf-base. The authors described this to be a constant character within the type material. Moreover, oblique leaf-bases seems to be no peculiarity because from the 3rd or 4th pair below the inflorescence, leaves in *P. odorata* are generally oblique at the base. A good example of oblique leaf-base is seen in J. McKeen's collection (No. B944) from Darwin, preserved in Herb. BRI, CANB, DNA and NT.

Moldenke (1971) recorded *P. goeringii* Turcz. in the synonymy of *P. odorata*. I have not seen the type of *P. goeringii*, but from its original description it seems to be a distinct species. It differs from *P. odorata* by its leaves being densely stellate-hairy beneath, the petiole about 15 cm long (which is more than double the length of *P. odorata*), the calyx equally and obtusely 5-toothed and corolla-lips densely pubescent within. The pubescence on the inside of corolla-lips places *P. goeringii* nearer to *P. pubescens*, but the stellate hairs beneath the lamina are different.

The type of *P. regularis* H.J. Lam has several characters in common with *P. odorata*. However, *P. regularis* differs in having fairly small flowers and strongly cordate-based leaves.

Affinities

P. odorata is closely related to *P. acuminata* R. Br. in having pubescent leaves, sessile flowers, pubescent corolla on the outside, exserted stamens and style, and a glabrous and non-glandular ovary. However, *P. odorata* may easily be identified by its leaves being mainly ovate-rotundate, shortly cuspidate-acuminate, rounded or subcordate at the base, entire, the inflorescence not lax, 4-15 (-20) cm broad, the corolla greenish-white or pinkish-white and 3.5-5.5 mm long, the style 3-5 mm long. *P. odorata* is also close to *P. hylandiana* in having pubescent leaves, exserted stamens and style and a glabrous ovary. The latter species may easily be distinguished by its leaves being covered with dendriform-stellate hairs, the pedicels 1.5-3 (-5) mm long, the corolla creamy or pale yellow, glabrous outside, and ovary glandular on top. Both *P. acuminata* and *P. hylandiana* are endemic in Australia whereas *P. odorata* is widespread in the Malesian region.

Acknowledgements

The author is grateful to Dr J.P. Jessop for comments on the draft of this manuscript and for translating into Latin the diagnosis of the new species; to Dr H.R. Toelken for discussions and suggestions on some nomenclatural problems encountered during this work; to Dr W. Vink for providing additional information from a wide range of material of *P. odorata* and its allied species in Herb. L; to Dr M.D. Crisp, Australian Botanical Liaison Officer, Kew, London, for checking the collections of *P. odorata*, *P. pubescens* and *P. vestita* at Kew and the BM, and for providing the photographs of the syntypes of *P. obtusifolia*; to Mr Ludwik Dutkiewicz for preparing the illustrations; to Miss Barbara Welling for typing the manuscript.

Thanks are also due to the Directors/Curators of the following institutions for the loan of herbarium specimens: A, ADW, BO, BR, BRI, CANB, CBG, DNA, JCT, K, L, LAE, MA, MEL, NSW, NT, NY, PERTH, PNH, PR, QRS, SING, US, Z.

References

Bailey, F.M. (1883). Verbenaceae. "A Synopsis of the Queensland Flora". 375-381. (J.C. Beal, Govt Printer: Brisbane).

Bailey, F.M. (1888). Verbenaceae. "Queensland Woods". edn 2: 90-93. (Queensland Commission: Brisbane).

Bailey, F.M. (1891). Contribution to the Queensland Flora. *Bot. Bull. Dept. Agric. Qld* 13: 14-15.

Baily, F.M. (1901). Verbenaceae. "The Queensland Flora". Part IV: 1164-1185. (H.J. Diddams & Co.: Brisbane).

Baily, F.M. (1913). Verbenaceae. "Comprehensive Catalogue of Queensland Plants". 381-387. (Govt Printer: Brisbane).

Bartling, F.G. (1830). "Ordines Naturales Plantarum". (Dietrich: Goettingen).

Batsch, A.J.G.K. (1802). "Tabula affinitatum regni vegetabilis". (Landes-Industrie comptoir: Weimar).

Beard, J.S. (1970). "A descriptive Catalogue of West Australian Plants". 2nd edn. (Society for Growing Australian Plants: Picnic Point, Sydney).

Beer, E. & Lam, H.J. (1936). The Verbenaceae collected in Papua by L.J. Brass for the Archbold Expedition. *Blumea* 2: 221-228.

Bentham, G. (1870). Verbenaceae. "Flora Australiensis". Vol. 5: 31-70. (L. Reeve & Co.: London).

Bentham, G. & Hooker, J.D. (1876). Verbenaceae. "Genera Plantarum". Vol. 2: 1131-1160. (L. Reeve & Co.: London).

Blanco, F.M. (1837). Didinamia Angiospermia. "Flora de Filipinas Segun el Sistema sexual de Linneo": 484-519. (En la imprenta de Sto. Thomas por D. Candido Lopez: Manila).

Briquet, J. (1895). Verbenaceae. In Engler, A. & Prantl, K. "Die natürlichen Plfanzenfamilien". IV, 3a: 132-182. (Wilhelm Engelmann: Leipzig).

Brongniart, A.T. (1843). "Enumeration des generes de plantes cultives au Museum d'histoire naturelle de Paris". (Fortin, Masson & Co.: Paris).

Brown, R. (1810). Verbenaceae. "Prodromus Florae Novae Hollandiae et Insulae Van-Diemen": 510-514. (Richard Taylor & Co.: London).

Burman, J. (1737). "Thesaurus zeylanicus, exhibens plantas in insula Zeylana nascentes . . . . . .". (Janssonius-Waesberg & Salomon Schauten: Amsterdam).

Burman, N.L. (1786). Didynamia Angiosperma. "Flora Indica": 126-139. (Johannes Schreuder: Amsterdam).

Collett, H. & Hemsley, W.B. (1891). On a Collection of Plants from Upper Burma and the Shan States. *J. Linn. Soc. Bot.* 28: 1-150.

Dakkus, P.M.W. (1957). "An Alphabetical List of Plant Species cultivated in the Hortus Botanicus Bogoriensis". (Foundation for Nature Research, Botanic Gardens, Indonesia: Bogor).

Dalla Torre, C.G. & Harms, H. (1904). Verbenaceae. "Genera Siphonogamarum ad Systema Englerianum Conscripta": 429-434. (Wilhelm Engelmann: Leipzig).

Dietrich, D. (1843). Didinamia Angiospermia. "Synopsis Plantarum". 3: 370-372, 600-620. (B.F. Voight: Weimar).

Domin, K. (1929). Beiträge zur Flora und Plfanzengeographie Australiens. *Bibl. Bot.* Heft 89(vi): 551-562.

Durand, Th. (1888). Verbenaceae. "Index Generum Phanerogamorum": 319-322. (Dulau & Co.: London).

Duthie, J.F. (1911). Verbenaceae. "Flora of the Upper Gangetic Plain and of the adjacent Siwalik and sub-Himalayan tracts". Vol. 2: 225-236. (Government of India Central Publication Branch: Calcutta).

Endlicher, S.L. (1841). Verbenaceae. "Enchiridion Botanicum": 311-314. (Wilhelm Engelmann: Leipzig).

Ewart, J. & Davies, O.B. (1917). Verbenaceae. "Flora of the Northern Territory": 235-239. (McCarron, Bird & Co.: Melbourne).

Fletcher, H.R. (1936). On the Identity of *Premna corymbosa* Rottl. et Willd. and *Premna integrifolia* Linn. *Notes Roy. Bot. Gard. Edinb.* 19: 177-178.

Fletcher, H.R. (1938). Nomenclature of *Premna obtusifolia* R. Br. *Taxon* 2: 88-89.

Francis, W.D. (1951). Verbenaceae. "Australian Rain-Forest Trees": 367-373. (Forestry and Timber Bureau: Sydney).

F.-Villar, C. (1880). "Novissima appendix to Blanco, Flora de Filipinas". Edn 3, Vol. 4. (Plana y C.a.: Manila).

Gaertner, J. (1788). "De Fructibus et Seminibus Plantarum". Vol. 1: 266-275. (G.H. Schramm: Tübingen).

Gardner, C.A. (1931). Verbenaceae. "Enumeratio Plantarum Australiae Occidentalis". Part 3: 111-113. (Govt Printer: Perth).

Giseke, P.D. (1792). "Caroli a Linne . . . Praelectiones in Ordines Naturales Plantarum". (B.G. Hoffmann: Hamburg).

Gmelin, J.F. (1791). "Caroli a Linne . . . . . Systema Naturae" per regna tria naturae, secundum classes, ordines, genera, species . . . . .". (B.E. Beer: Leipzig).

Hooker, J.D. (1859). "The Botany of the Antarctic Voyage". Part III. Flora Tasmaniae. Vol. 1: XLVI. (L. Reeve & Co.: London).

Hooker, J.D. (1885). Verbenaceae. "The Flora of British India". Vol. 4: 560-604. (L. Reeve & Co.: Ashford).

Junell, S. (1934). Zur Gynäceummorphologie und Systematik der Verbenaceen und Labiaten. *Symb. Bot. Ups.* 4: 1-219.

Jussieu, A.L. de (1789). Vitices. "Genera Plantarum Secundum Ordines Naturalis Disposita": 106-110. (Viduam Herissant & T. Barrois: Paris).

Jussieu, A.L. de (1806). Sur la famille des Plantes Verbenacees. *Ann. Mus. Hist. Nat. Paris* Vol. 7: 63-77.

King, G. & Gamble, J.S. (1909). Verbenaceae. "Material for a Flora of the Malayan Peninsula". Vol. 4: 1004-1079. (W. Newman & Co.: London).

Lam, H.J. (1919). "The Verbenaceae of the Malayan Archipelago". (M. De Waal: Groningen).
Lam, H.J. & Bakhuizen van den Brink, R.C. (1921). Revision of the Verbenaceae of the Dutch East-Indies and Surrounding Countries. *Bull. Jard. Bot. Buitenz.* III. 3: 1-116.
Lemée, A. (1943). Verbenaceae. "Dictionnaire descriptif et synonymique des generes de plantes phanerogames". Vol. 8b: 650-657 (Imprimerie Commerciale et Administrative: Brest).
Linnaeus, C. (1747). "Flora Zeylanica". (Laurentius Salvius: Stockholm).
Linnaeus, C. (1771). "Mantissa Plantarum Altera Generum editionis VI & Specierum editionis II". (Laurentius Salvius: Stockholm).
Lourteig, A. (1966). L'Herbier De Paul Hermann, Base Du Thesaures Zyllanicus De John Burman. *Taxon* 15: 23-33.
Maiden, J.H. (1889). "The Useful Native Plants of Australia including Tasmania". (Turner & Henderson: Sydney).
Meeuse, A.D.J. (1942). Notes on Javanese Verbenaceae. *Blumea* 5: 66-80.
Meisner, C.F. (1840). Verbenaceae. "Plantarum Vascularium Genera Secundum Ordines Naturalis Digesta . . . . .". Vol. 1. "Tabulis Diagnosticis": 290-292. Vol. 2. "Commentarius": 197-200. (Libraria Weidmannia: Leipzig).
Melchior, H. (1964). "Tubiflorae" in Melchior, H. (Ed.), "Engler's Syllabus der Pflanzenfamilien". edn 12. Vol. 2: 424-471. (Borntraeger Brothers: Berlin).
Merrill, E.D. (1905). Verbenaceae. "A Review of the Identifications of the Species described in Blanco's Flora of de Filipinas": 67-69. (Bureau of Public Printing: Manila).
Merrill, E.D. (1906). The Flora of the Lamao Forest Reserve. *Philip. J. Sc.* Vol. 1, Suppl. 1: 121-123.
Merrill, E.D. (1910). New or Noteworthy Philippine Plants, VIII. *Philip. J. Sc.* 5(3): 167-235.
Merrill, E.D. (1917). Verbenaceae. "An Interpretation of Rumphius's Herbarium Amboinense": 448-456. (Bureau of Printing: Manila).
Merrill, E.D. (1918). Verbenaceae. "Species Blancoanae": 330-336. (Bureau of Printing: Manila).
Merrill, E.D. (1923). Verbenaceae. "An Enumeration of Philippine Flowering Plants". Vol. 3: 380-408. (Bureau of Printing: Manila).
Merrill, E.D. (1951). *Tatea* F. Mueller (*Pygmaeopremna* Merrill) and *Premna* Linnaeus. *J. Arn. Arb.* 32: 73-78.
Miquel, F.A.W. (1858). Verbenaceae. "Flora Indiae Batavae". Vol. 2: 856-913. (C.G. van der Post: Amsterdam).
Moldenke, H.N. (1959). "A Résumé of the Verbenaceae, Avicenniaceae, Stilbaceae, Symphoremaceae, and Eriocaulaceae of the World as to valid Taxa, Geographic Distribution and Synonymy". (H.N. Moldenke: Mountain, New Jersey).
Moldenke, H.N. (1971). "A Fifth Summary of the Verbenaceae, Avicenniaceae, Stilbaceaa, Dicrastylidaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World as to valid Taxa, Geographic Distribution, and Synonymy". Vol. 1 & 2. (H.N. Moldenke: Wayne, New Jersey).
Moldenke, H.N. (1980). "Phytologia Memoirs II. A Sixth Summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Chloanthaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World as to valid Taxa, Geographic Distribution and Synonymy". (H.N. Moldenke & A.L. Moldenke: Plainfield, New Jersey).
Moldenke, H.N. & Moldenke, A.L. (1983). Verbenaceae. In Dassanayake, M.D. & Fosberg, F.R., "A Revised Handbook to the Flora of Ceylon". Vol. 4: 196-487. (Amerind Publishing Co. Pvt. Ltd.: New Delhi).
Mueller, F.v. (1862). "Fragmenta Phytographiae Australiae". Vol. 3. (Govt Printer: Melbourne).
Mueller, F.v. (1882). Verbenaceae. "Systematic Census of Australian Plants". Part 1. Vasculares: 102-103. (McCarron, Bird & Co.: Melbourne).
Mueller, F.v. (1883). Diagnosis of a New Genus of Verbenaceae from Arnhem Land. *Trans. Proc. & Rep. Roy. Soc. S. Aust.* 6: 33-34.
Mueller, F.v. (1889). Verbenaceae. "Second Systematic Census of Australian Plants". Part 1. Vasculares: 171-173. (McCarron, Bird & Co.: Melbourne).
Munir, A.A. (1982). Taxonomic Revision of the genus *Callicarpa* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 6(1); 5-39.
Murray, J.A. (1774). "Caroli a Linne . . . . . Systema Vegetabilium Secundum Classes Ordines Genera Species cum Characteribus et Differentiis". (J.C. Dietrich: Göttingen).
Necker, N.J. (1790). "Elementa Botanica Genera Genuina, Species Naturales Omnium Vegetabilium . . . . .". (Societas Typographica: Neowedae ad Rhenum).
Persoon, C.H. (1797). "Caroli a Linne Systema Vegetabilium Secundum Classes Ordines Genera Species . . . . .". (J.C. Dieterich: Göttingen).
Poiret, J.L.M. (1823). In Lamark, J.B.P.A.M. & Poiret, J.L.M., "Tableau Encyclopédique et Methodique des trois Regnes de la Nature Botanique . . . . .". (Chez Mme Ve Agasse: Paris).
Reichenbach, H.G.L. (1828). Labiatae. "Conspectus Regni vegetabilis per Grades naturales evoluti". Part 1: 115-117. (Carolus Cnobloch: Leipzig).
Rottler, J.P. (1803). Botanische Bemerkungen auf der Hin-und Rückreise von Trankenbar nach Madras. *Ges. Naturf. Freunde Berlin Neue Schriften.* Vol. 4: 181-203.
Roxburgh, W. (1820). Tetrandria Monogynia. "Flora Indica or Description of Indian Plants. Edited by William Carey, to which are added descriptions of plants more recently discovered by N. Wallich". Vol. 1: 405-411. (Mission Press: Serampore, Calcutta).
Schauer, J.C. (1847). Verbenaceae. In De Candolle, A., "Prodromus Systematis Naturalis Regni Vegetabilis". Vol. II: 522-700. (Victoris Masson: Paris).
Schumann, K. & Hollrung, M. (1889). Verbenaceae. "Die Flora von Kaiser Wilhelms Land": 118-122. (Asher & Co.: Berlin).

Schreber, J.C.D. (1791). "Caroli a Linne Genera Plantarum . . . . ." Edito Octava. Post Reichhardianam, Secunda, prioribus longe auctior atque emendatior". (Warrentrapp et Wenner: Frankfurt a/M).

Scopoli, G.A. (1777). "Introductio ad Historiam Naturalem sistens genera Lepidum, Plantarum et Animalium . . . . .". (W. Gerle: Prague).

Spach, E. (1840). "Histoire Naturelle des Vegetaux Phanerogams". Vol. 9: 225-243. (Librarie Encyclopedique de Roret: Paris).

Sprengel, K. (1825). Didynamia Angiospermia. "Caroli Linnaei . . . . . Systema Vegetabilium". edn 16. Vol. 2: 747-765. (Dietrich: Göttingen).

Sprengel, K. (1831). Didynamia Angiospermia. "Genera Plantarum". (Edito nona of Linnaeus Genera plantarum) curante curtio Sprengel. Vol. 2: 476-483. (Dietrich: Göttingen).

Walpers, W.G. (1845). Verbenaceae. "Repertorium Botanices Systematicae". Vol. 4: 3-134. (Fr. Hofmeister: Leipzig).

Willdenow, C.L. (1800). Didynamia Angiospermia. "Caroli a Linne species Plantarum Exhibentes Plantas Rite cognitas Ad Genera Relatas . . . . .". Vol. 3: 1-403. (G.C. Nauk: Berlin).

Index to Scientific Names

Names

New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked refer to figures and maps.

J. Adelaide Bot. Gard. 7(1): 45-89 (1984)

THE GENUS *MICROTIS* R. BR. (ORCHIDACEAE): A TAXONOMIC REVISION WITH NOTES ON BIOLOGY

R. Bates

38 Portmarnock Street, Fairview Park, South Australia 5126

Abstract

A taxonomic revision of *Microtis* is presented in which nine species are recognised; *M. globula* is described as new. *M. brownii, M. magnadenia* and *M. truncata* are placed in synonymy with *M. rara. M. media* is treated as a synonym of *M. unifolia.* The biology, taxonomic affinities and distribution are considered for each species, a key is provided and a detailed description of each species is supplemented with illustrations.

Introduction

Since Robert Brown (1810) described *Microtis* there have been numerous taxa added but no complete revision has appeared, nor has any flora dealt with all species. Bentham (1873, p. 269) when discussing the difficulty of determining many Australian orchids, including *Microtis*, from dried material wrote, "It is to be hoped that the revision of these . . . will be taken on by resident botanists who have the opportunity of studying them in the fresh state". With this in mind the present author has observed, photographed and collected all species of *Microtis* in the process of completing this revision. Plants were obtained from as many locations as possible and cultivated in Adelaide and populations of all Australian species studied in the field. Endophytic soil fungi on *Microtis* were isolated and identified by Dr J. Warcup (Waite Agricultural Research Institute). Chromosome counts were attempted but results were inconclusive.

Loans were obtained from numerous herbaria (see acknowledgements). Types of all taxa were examined unless otherwise indicated in the text. Where necessary lectotypes have been chosen. In some cases these are the ones selected by George (1971) but designated by him as holotypes. They should, however, be lectotypes as suggested by Stearn (1960). The terminology used follows Dressler (1981).

History of taxonomy

The genus

Brown (1810), when describing the genus, placed it in the Orchidaceae (as Orchideae), section *Monandrae* Sw., (flowers with a single terminal anther).

Lindley (1826, 1840) placed *Microtis* in tribe Arethusae Lindley, division Eu-arethuseae for plants with an opercular anther and a clinandrium, but he noted that the genus was, " . . . passing into Neottieae", (anther dorsal, inclined or erect, column without a definite clinandrium), the tribe in which Bentham (1873) placed the genus.

Bentham & Hooker (1883) included *Microtis* in the sub-tribe Diuridinae Lindley for plants with a very short column and terminal viscidium, but Schlechter (1911) placed the genus in his sub-tribe Prasophyllinae (plants with very short columns bearing lateral wings; leaves solitary and hollow-terete).

Rogers (1927) described from Western Australia, a new genus *Goadbyella*, recognised as being an aberrant *Microtis* by George (1961, 1971).

Mansfeld (1937) included the sub-tribe Prasophyllinae in sub-tribe Thelymitrinae Lindley (rostellum bifid, column with lateral appendages, leaf solitary, elongate, generally glabrous).

Vermeulen (1966) inferred that the genus belonged in sub-family Epidendroideae (Vermeulen) Vermeulen, contribe Neottianthae Vermeulen for plants with pollinia in tetrads, rostellum cleft, anther persistent or deciduous. This treatment, placing *Microtis* in tribe Neottieae, was followed by Cady (1967), Dockrill (1969) and Jacobs & Pickard (1981).

Dressler (1981) placed *Microtis* in the subfamily Orchidoideae Lindley, tribe Diurideae Endl. (pollinia in two pairs, anther erect and projecting beyond the stigma; characterised by plants with root-stem tuberoid) subtribe Prasophyllinae. This classification is accepted here with reservations.

The species (See table 1)

There has been much confusion over the identity of Brown's (1810) species and the extent of their variability. Brown's failure to place *Ophrys unifolia* Forster f. (1786) and *Epipactis porrifolia* Sw. (1800) with his *M. media* led to duplication of names which has persisted to the present. The very small size of *Microtis* flowers, the variable morphology of some species and the tendency for the shape of the flowers to change during drying has caused further confusion and numerous taxa (Table 1) have been erected on the basis of minor (perceived) differences in flower shape. This confusion is shown in the comments of major workers in the Orchidaceae during the nineteenth century. J.D. Hooker (1860, appendix p. 372) commenting on his own work, wrote, "On re-examining the Australian and Tasmanian species of *Microtis* with the descriptions and drawing in this work, I find them to be inextricably confused". Bentham (1873, p. 209) made similar comment and he (p. 348) apparently confused Brown's *M. media* and *M. rara*. His description of the former clearly belongs to the latter. He listed *M. rara* as a synonym of *M. porrifolia* (Sw.) Sprengel; an error perpetuated by most later authors.

The situation was even more difficult for resident Australian botanists who were unable to view type specimens. Mueller (1855) wrote that ". . . . . the *Microtis* so common through South Australia . . . . . is unquestionably *M. media* R. Br." yet in 1866 he used *M. viridis* F. Muell., nom. illeg. for the same plants and in 1882 replaced that name with *M. porrifolia*! Reichenbach (1871) and Bentham (1873) reduced many names to synonymy but added further taxa of their own. Bentham (1873) accepted just six Australian species but workers from 1900-1949, notably Rogers and later Nicholls added many new taxa. In 1950 the number of Australian taxa had grown to seventeen. George (1971) reduced some of these to synonymy and accepted only seven species from Western Australia and Green (1981) listed only six. Clements (1982) accepted ten Australian *Microtis* species, although (pers. comm. 1983) he has suggested that some were probably synonymous.

In Asia the first record for the genus was given by Reichenbach (1857) when he described *M. javanica*. Kraenzlin (1885) determined Asian plants as *M. unifolia* and this was accepted by Ames (1908) and Garay and Sweet (1974) although Schlechter (1911), Makino (1965) and others used different names (*M. formosana* Schltr, *M. parviflora* R. Br.). Garay & Sweet gave *M. parviflora* as a synonym of *M. unifolia* but they were referring to Asian plants and this treatment has never been accepted in Australia or New Zealand.

The most recent species to be described was *M. oligantha* L.B. Moore (1968) from New Zealand.

Table 1. Chronological chart of nomenclature

Original name	Accepted name, where different from original	Author affecting synonymy
Ophrys unifolia Forster f. 1786	= *Microtis unifolia*	Reichb. f. 1871
Epipactis porrifolia Sw. 1800, nom. illeg.	= *M. unifolia*	Reichb. f. 1871
Microtis alba R. Br. 1810		
M. media R. Br. 1810	= *M. unifolia*	syn. nov. Bates, 1984.
M. parviflora R. Br. 1810		
M. pulchella R. Br. 1810		
M. rara R. Br. 1810		
Serapias porrifolia (Sw.) Steudel 1824	= *M. unifolia*	syn. nov. Bates, 1984.
Microtis porrifolia (Sw.) Sprengel 1826	= *M. unifolia*	Reichb. f. 1871
M. banksii Hook. 1835	= *M. unifolia*	Ames 1908
M. atrata Lindley 1840a		
M. arenaria Lindley 1840b	= *M. unifolia*	Reichb. f. 1871
M. pulchella var. *vivax* Lindley 1840b	= *M. unifolia*	Reichb. f. 1871
Micropera banksii, M. media, M. parviflora and *Microtis pallida* Heynhold 1840	= Nomina dubia. See p. 81	
Microtis frutetorum Schltdl. 1847	= *M. unifolia*	Ames 1908
M. javanica Reichb. f. 1857	= *M. unifolia*	Ames 1908
M. minutiflora F. Muell. 1859	= *M. atrata*	F. Muell. 1866
M. viridis F. Muell. 1866 nom. illeg.	= *M. parviflora* p.p., *M. rara* p.p., = *M. unifolia* p.p.	
M. brownii Reichb. f. 1871	= *M. rara*	syn. nov. Bates, 1984.
M. benthamiana Reichb. f. 1871	= *M. parviflora*	Benth. 1873
M. unifolia var. *rara* (R. Br.) Reichb. f. 1871	= *M. rara*	syn. nov. Bates, 1984.
M. atrata var. *viridula* Reichb. f. 1871	= *M. atrata*	A.S. George 1971
M. parviflora var. *densiflora* Benth. 1873	= *M. unifolia*	A.S. George 1971
M. papillosa Colenso 1885	= *M. unifolia*	Cheeseman 1925
M. longifolia Colenso 1886	= *M. unifolia*	Cheeseman 1925
M. gymnadenioides Diels 1903	= *M. pulchella*	A.S. George 1971
M. porrifolia var. *parviflora* (R. Br.) Rodway 1903	= *M. parviflora*	W.M. Curtis 1953
M. aemula Schltr. 1907	= *M. unifolia*	Ames 1913
M. formosana Schltr 1907, nom. nud.	= Nomen dubium	
M. orbicularis R. Rogers 1907		
M. truncata R. Rogers 1920	= *M. rara*	syn. nov. Bates, 1984
M. oblonga R. Rogers 1920	= *M. rara*	W.M. Curtis 1981
Goadbyella gracilis R. Rogers 1927	= *M. alba*	A.S. George 1971
Microtis magnadenia R. Rogers 1930	= *M. rara*	syn. nov. Bates, 1984
M. biloba Nicholls 1949	= *M. unifolia*	D.L. Jones 1976
M. bipulvinaris Nicholls 1949	= *M. parviflora*	D.L. Jones 1976
M. holmesii Nicholls 1949	= *M. parviflora*	Beauglehole 1978
M. oligantha L.B. Moore 1968		

Biology

Germination

Orchid seed will germinate successfully in nature only with the aid of endo-mycorrhiza (Burgeff in Withner 1957). The process of infection of the orchid seed through the suspensor (micropyle) end by fungal hyphae is described briefly by Dressler (1981).

The fungal endophytes associated with *Microtis* include the Rhizoctonias, *Tulasnella* spp. particularly *T. calospora*, and *Sebacina vermifera* (Warcup 1981). *Microtis* seed has also been germinated asymbiotically in nutrient cultures (Stoutamire 1964). Stoutamire

(p. 265) illustrates a protocorm of *M. unifolia*. In nature, mature plants continue to grow in symbiotic association with soil fungi (Warcup pers. comm.) *Microtis* plants cultivated from seed have been observed to flower in their second year but observation of wild plants indicates that they do not normally flower until they are 3 years old.

Annual Growth

Each summer after forming 1-3 new tuberoids the *Microtis* plant dies down. The dormant period may begin as early as October for *M. unifolia* growing in dry areas and last up to six months. In the semi-aquatic *M. orbicularis* the new tuberoid may begin to sprout before the old plant has died off.

The author has all species in cultivation in Adelaide. The tuberoids sprout after the first soaking autumn rains; growth is rapid while the soil is warm but slows during winter, and becomes more rapid again in spring. There may be no sign that a plant will flower until 4-6 weeks before the event when a slight swelling can be seen (or felt) within the base of the tubular leaf. The spike develops quickly and emerges through a split or fissure which appears at a point along the longitudinal line seen on the leaf of flowering plants.

Flowering

Flowering in temperate regions occurs in spring and summer. The lowest flower on the raceme generally opens first and flowering proceeds upwards in a somewhat spiral fashion. In some species, i.e. *M. parviflora*, the seed capsules on the lowest flowers may have ripened and released their seed while the uppermost flowers are still in bud. The time from anthesis to dehiscence of seed capsules varies from 2-6 weeks.

Pollination

Microtis flowers are structurally suited for pollination by small insects. Most species have a nectary at the base of the labellum and many are lightly perfumed. The flowers are not colourful and face slightly downward. Because the plants are colonial with numerous flowers per raceme, one would expect them to be pollinated by gregarious low-flying or crawling insects. Observation in the field has shown *Microtis* flowers are commonly visited by flies, beetles, ants and small wasps. The latter two are often observed to successfully transfer pollinia (Jones 1975, Bates 1981a). If insect activity fails to bring about pollination, autogamy occurs 2-7 days after anthesis depending on the species (see later). Parthenocarpy has also been reported (Bates 1983b).

Insect Pollination

Jones (1975) documented the pollination of *M. parviflora* in Victoria by small black ants (chiefly *Iridomyrmex* sp.). The ants, attracted by nectar secretions, had the viscidium of the orchid cemented to their frons while feeding and on visits to subsequent flowers the pollen massulae were stripped away layer by layer. The present author has also observed similar ants as pollen vectors on *M. parviflora* near Adelaide, South Australia. As noted by Jones, the ants mainly visited flowers which had been open less than 4 days, as in older flowers autogamy had already begun and nectar was no longer produced. Most pollen transfer was to flowers on the same plant, but some outcrossing was observed.

Bates (1981a) described pollination of a mixed population of *Microtis rara*, *M. unifolia* and their putative natural hybrid by tiny wasps (*Ichneumonidae* and *Brachonidae*). The wasps collected the pollinarium on their heads and it was noted that the pollinia fell slightly under their own weight or by rotation of the caudicle so as to be in a position to contact the stigma of the next flower visited. The flying wasps ensured effective outcrossing. Wasps have also been noted as pollen vectors on *M. alba*, a fragrant species producing much nectar. The author has observed populations of *M. pulchella* and

M. orbicularis which had pollinia removed by small diptera, but these flies scraped the pollinia off their heads on to various parts of the raceme and were not seen to effectively transfer pollen.

Autogamy

Autogamy in *Microtis* was first described by Thompson (1879) who noted that the pollen grains in *M. unifolia*, if not removed, ". . . emit a great mass of tubes which penetrate the upper margins of the stigma". Rarely does one find a mature capsule of any *Microtis* species which does not contain numerous viable seeds, and in such cases the lack of seed appears due to injury or disease. Plants cultivated in an insect-free environment produce seed in every capsule (Bates unpubl.).

Flowers of *M. unifolia* at different stages of development were examined microscopically to determine the process of autogamy (Fig. 1). Immediately after anthesis the pollinia are enclosed by the anther cells. The threadlike caudicle and sticky spherical viscidium (Fig. 1A) situated on the apex of the rostellum are clearly visible. The stigma at this stage has a smooth concave lamina with regular margins, the rostellum erect above it. Over the next few days the upper border of the stigma grows over the rostellum, covering the viscidium, the whole surface of the stigma becoming tuberculate, the margins irregular. During this time the pollinia separate from the anther cells, the caudicle contracts as it dries and the pollen massulae separate (Fig. 1B). Depending on the population observed the pollinia contact the upward-growing stigma from 2-7 days after anthesis (Fig. 1C). Pollen tubes grow through the front, top and rear of this stigmatic extension. Nectaries at this stage have dried up and insects are no longer attracted. Jones (1975) described in detail a similar process in *M. parviflora*.

Apomixy

Bates (1983b) described how *M. orbicularis* flowers set viable seed even if the stigma is excised as the flowers open. In *M. unifolia*, a species with apparent heterozygous and homozygous races, the homozygous races appear to have resulted from apomixy as flowers from these monomorphic forms will set viable seed even if their stigma is excised. The flowers of polymorphic races tested did not set seed under the same circumstances (Bates unpubl.). Jones (1975) reported that the populations of *M. parviflora* studied by him did not appear to be apomictic. The success of *M. unifolia* as a species probably depends partly on its ability to utilise a wide range of fertilisation processes.

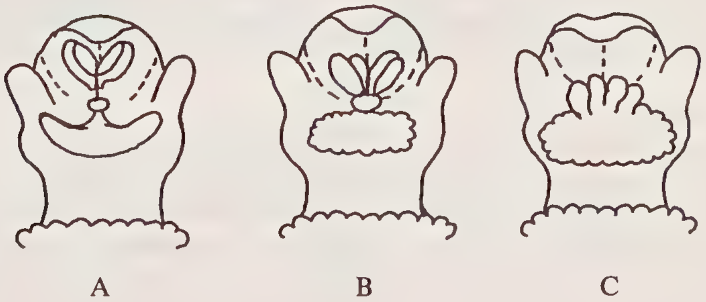


Fig. 1 Development of column in *M. unifolia*. A, at anthesis; B, 1-2 days after anthesis; C, 3-7 days after anthesis with autogamy having been effected. Illustration by G.R.M. Dashorst.

Seed dispersal

Seed develops rapidly after fertilisation and ripe seed may be shed after 14-21 days. Dehiscence of the seed capsule occurs along 3 or 6 vertical slits. Numerous seeds are released 0.2-0.4 mm long (Fig. 2A) and being very light these are dispersed by wind or, in the case of swamp species, by water, or in mud on the feet of water birds.

Stimulation by fire

All species appear to flower more profusely after a fire and two, *M. pulchella* and *M. globula* have only been observed to flower 9-12 months after a late summer fire (R. Heberle pers. comm. 1982). Burning of the surrounding vegetation increases the amount of light available to the orchids and boosts potassium and phosphorus in the mineral-deficient soils in which most species grow, but it seems likely that some other physiological stimulus may also be involved as *Microtis* plants provided with increased light and covered with ashes in cultivation are not stimulated to flower.

Photosynthesis by flowers

Arditti (pers. comm. 1981) suggests that most parts of the green flowers of *Microtis*, including the column are photosynthetic.

Vegetative reproduction

Species of the *M. unifolia* complex annually produce more than one tuberoid at the end of the 3-8 cm long roots (Fig. 2B). Non-flowering plants of this complex also produce a new tuberoid adjacent to the old. Clonal colonies of more than 1000 plants may develop (particularly with *M. unifolia*) in areas where flowering is not stimulated. Along creeks and where animals disturb the tuberoids these vegetatively increasing clones may spread over great distances. *M. orbicularis* sometimes produces two new tuberoids adjacent to the old so that the plants form clumps (Fig. 2C). *M. atrata* and *M. pulchella* produce new tuberoids adjacent to the old and also at the ends of their roots to produce very dense colonies (Fig. 2D). In cultivation an annual vegetative increase of fourfold has been achieved with *M. rara*.

Cytology

Dressler (1981) gave a chromosome number of $2n = 44$ for the subtribe Prasophyllinae. Tanaka (1965) gave $2n = 44$ as the number of chromosomes in some Japanese species (*M. unifolia* or *M. parviflora*). Preliminary investigations by Molloy (pers. comm. 1983) gives counts of $2n = 44$ for *M. parviflora* from Australia and *M. oligantha* from New Zealand while he obtained $2n = 88$ for New Zealand plants of *M. unifolia*.

Origin and Evolution

According to Dressler (1981) genuine fossil records of the Orchidaceae are unknown so that discussion of *Microtis* evolution is purely speculative. Hatch (1963) stated that *Microtis* was a ". . . truly Asian genus" without giving reasons but Rogers (1923, p. 230) had suggested that species in the genus originated in Australia, which is more likely as eight of the nine *Microtis* species occur in Australia and six of these are endemic. The genus reaches its greatest diversity and number of species in southern Australia and the hypothesis is that *Microtis* arose in that area some time after Australia separated from the rest of Gondwanaland, possibly quite recently. Most species of *Microtis* are swamp dwellers and this could indicate that the genus arose in the area during a very moist climatic period.

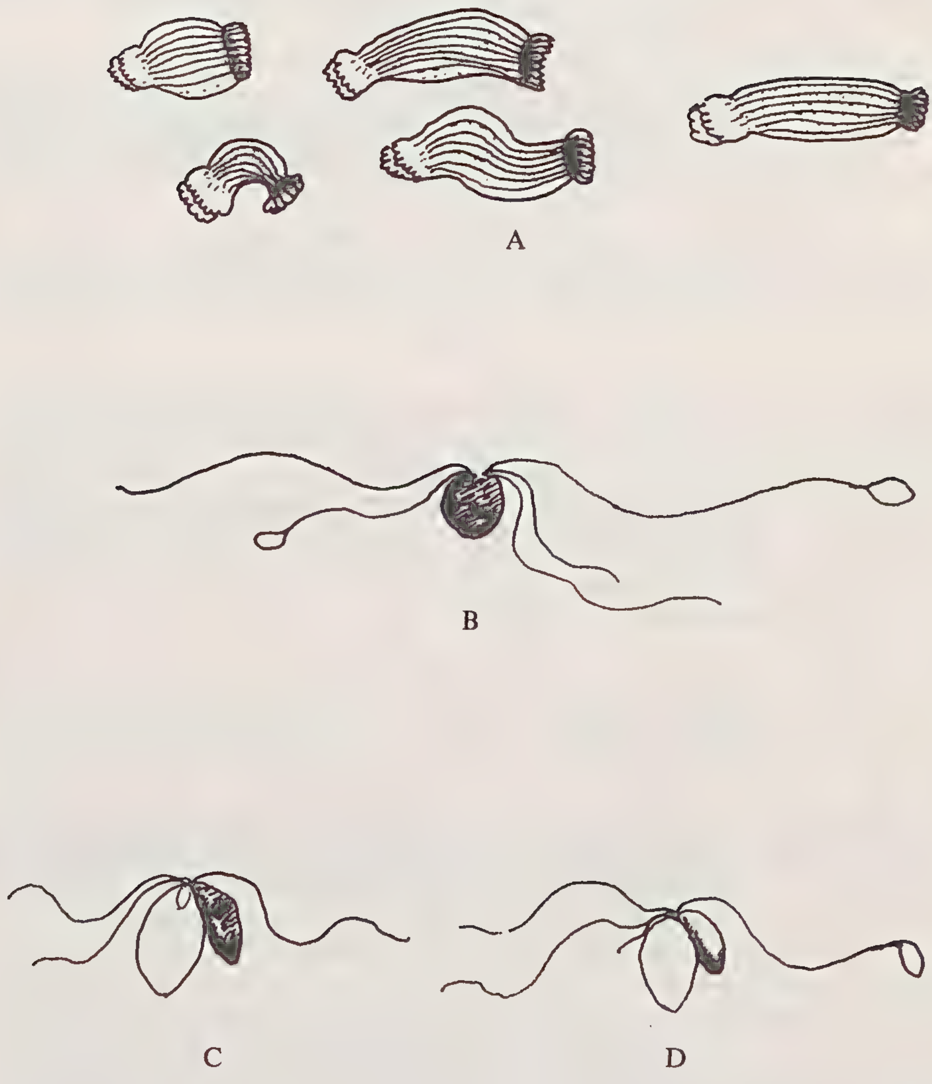


Fig. 2. A, seeds of *M. pulchella* showing variation found within a single capsule, ×100; B, tuberoid and root pattern of *M. alba*; C, tuberoid and root pattern of *M. orbicularis*; D, tuberoid and root pattern of *M. atrata*.

Taxonomic criteria

Vegetative

Microtis species can be divided into three groups on the basis of vegetative characters.

The first group, containing *M. atrata, M. orbicularis* and *M. pulchella* has ovoid tubers (Figs 2C, 2D) with an outer epidermis which turns white and separates when dry. The leaf in these species is relatively solid above the fissure through which the flower spike emerges and has a comparatively short, rigid apex.

The most complex group containing *M. alba, M. oligantha, M. parviflora, M. rara* and *M. unifolia*, and here referred to as the *M. unifolia* complex, has globose tubers (Fig. 2B) which turn brown when dry and have the outer epidermis intact. The leaf of each is hollow above the fissure, with the apex loosely erect or drooping, rather long, but usually damaged. The flowers of species in the *M. unifolia* complex are similar in structure and vary considerably in size within each species.

The remaining species, *M. globula* does not fit into either group. It differs vegetatively in having very small tubers and swollen roots (Fig. 3A). Its distinctly globular flowers also serve to separate it from other species.

Floral

Features useful in distinguishing the species include the labellum structure (shape, size, texture of margins; number, size and shape of calli); the position of the lateral sepals and petals; the shape of the dorsal sepal; the flower size and colour; the length and density of the inflorescence. No one feature alone is sufficient to determine all species although labellum shape is most useful in separating all except *M. unifolia* and *M. oligantha*. The column is of very little value in identification of species as it is essentially uniform among species within the genus: yet there is always some degree of change in column morphology during the development of a single flower! (Fig. 1).

Hybrids

A number of probable hybrids between species of *Microtis* have been noted. The morphology of some of these putative hybrids has been studied and populations monitored in the field.

Effective interspecific transference of pollinia in *Microtis* by small hymenopterans has been observed (Bates 1981a), and Brown (1982) notes the occurrence of probable *Microtis* hybrids in Western Australia. All suspected hybrids have been between the closely related species of the *M. unifolia* complex. Such hybrids are intermediate in character between their putative parents and are quite fertile so that backcrossing results in formation of hybrid swarms. Such hybrids are not common and reasons for the breakdown of normal barriers to hybridising are unclear. Sympatric populations of two or more species in the *M. unifolia* complex are commonly encountered, usually with no sign of crossing. Hybrid populations encountered are usually in areas disturbed by cultivation or road making.

The hybrids are difficult to recognise once dried and collections cited below as possible hybrids are those which have been inferred as such by the collector, or have come from populations which have been studied by the author.

M. alba × *M. unifolia*:

Brown (1982) records this putative hybrid from Western Australia. A number of collections are morphological intermediates and may represent hybrids e.g. *Ashby 2681*, 22.x.1968, near Pemberton (AD).

M. rara × *M. unifolia*:

Observation of pollen vectors on putative hybrids of *M. rara* and *M. unifolia* was recorded by Bates (1981a). Collections at AD include *R. Bates 575*, 16.xi.1979, Glen Shera Swamp (specimens exhibiting hybrid vigour) and *D. Hunt 2723*, 6.xi.1966, Myponga. I have also examined specimens intermediate between *M. rara* and *M. unifolia* from New South Wales, Victoria and Tasmania.

Intermediates between *M. parviflora* and *M. unifolia* have been encountered.

Cultivation

The small flowers ensure that this has not become a popular genus with orchid growers, but French (1886), Nash (1967), Palmer (1967) and Bates (1981b) discuss some aspects of the cultivation of *Microtis*.

Pathology

The leaves of *Microtis* appear particularly susceptible to fungal diseases and it is unusual to find unblemished leaves in nature at flowering time. McAlpine (1895) records the rust *Uromyces microtidis* Cooke, as commonly found on the leaves of *M. unifolia*.

Chemistry

Brunnich (1914) and Lawler & Slaytor (1969) discuss the presence of alkaloids in *Microtis parviflora* and *M. unifolia*.

Ethnobotany

Lawler (1981) cites references which indicate that the Aborigines used *Microtis* tubers for food.

MICROTIS R.Br.

Microtis R. Br., Prod. 320 (1810); Lindley, Gen. sp. orch. pl. 395 (1840); Reichb. f., Beitr. Syst. Pfl. 24 (1871); Benth., Fl. Aust. 6: 346 (1873); Nicholls, Orch. Aust. 23 (1969); Dockr., Aust. Indig. Orch. 89 (1969); A.S. George, Nuytsia 1 (2): 184 (1971).

Lectotype: *M. rara* R. Br. vide Garay & Sweet, Fl. Ryukyu Isl. (1974).

Garay & Sweet state that the type of *M. rara* is closest to Brown's original description of the genus. (Halle (1976) gives *M. parviflora* R. Br. as the type species for the genus but Garay & Sweet's choice of lectotype must be given preference).

Goadbyella R. Rogers, Trans. Proc. R. Soc. S. Aust. 31: 293 (1927).

Holotype: *G. gracilis* R. Rogers.

Derivation of "Microtis" is from the Greek '*mikros*' meaning small, and '*otos*' an ear, and refers to the small membranous auricles of the column.

Perennial, erect, green geophytes, arising annually from ovoid or spheroid tuberoids. *Leaf* solitary, terete, tubular, elongate, erect, exuding clear mucilage if damaged; longitudinal furrow from base almost to apex splits to provide fissure through which flower spike emerges. *Inflorescence* a terminal raceme. *Flowers* very small, few to numerous and spirally arranged, resupinate, dichogamous, subtended by small clasping bract. *Perianth* zygomorphic, minutely tuberculate. *Dorsal sepal* cucullate, concave below. *Lateral sepals* free, narrower. *Lateral petals* smaller than sepals, of thin texture, spreading below or within the dorsal sepal. *Labellum* sessile, pendulous or decurved against the ovary, orbicular, ovate, oblong, cordate or cuneate; calli if present a smooth pair or single

one at the base, sometimes with a single irregular one near the apex; nectary indistinct or a shallow groove at base of labellum. *Column* within and below the dorsal sepal, semi-cylindrical. *Stigma* prominent, immediately below the anther; rostellum indistinct. *Anther* terminal, retuse. *Pollinarium*: two pairs of unequal, granular pollinia, loosely enclosed within the anther cells, often in massulae, connected basitonically directly or via a short mucilaginous, thread-like caudicle to the viscidium. *Ovary* large compared with flowers, tumescent, ellipsoid-cylindrical, minutely tuberculate; ventral surface flattened, with two marginal ribs; dorsal surface rounded, with a single median longitudinal rib. *Seeds* numerous, ovoid-cylindrical, 0.2-0.4 x 0.1 mm, shining brown with darker coloured longitudinal ridges.

Distribution (See table 2)

Microtis is the most widespread orchid genus of probable Australian origin, occurring throughout temperate Australia and into sub-tropical Queensland, throughout New Zealand as far south as Stewart Island and possibly Auckland Island; in the western Pacific (Norfolk, Lord Howe and Kermadec Islands and New Caledonia); Malaysia and Indonesia (mainly mountain areas); the Philippines, Taiwan, southern Japan, the Ryukyu Islands and probably on the Chinese mainland. *Microtis* is most commonly found in damp situations or in areas of high rainfall.

Table 2. Occurrence of *Microtis* species in Australian States, with indication of non-Australian distribution

Microtis	W.A.	Qld.	N.S.W.	Vic.	Tas.	S.A.	Other
1. *atrata*	*			*	*	*	
2. *orbicularis*	*			*	*	*	
3. *globula*	*						
4. *pulchella*	*						
5. *parviflora*		*	*	*	*	*	New Zealand; (Lord Howe? Norfolk Island? New Caledonia? & East Asia?)
6. *unifolia*	*	*	*	*	*	*	New Zealand, Indonesia, Polynesia, East Asia.
7. *oligantha*							New Zealand
8. *rara*	*	*	*	*	*	*	
9. *alba*	*						

Willis (1962) gives the vernacular name 'Onion-orchid' for all species of *Microtis*. The name probably derives from the hollow, terete mucilaginous leaves. Erickson (1951, 1965) uses 'Mignonette orchid' as a vernacular name.

Affinities

Microtis was placed with *Prasophyllum* R. Br. by Schlechter (1926) a position retained in the most recent classification (Dressler 1981). However, this classification is based on superficial resemblance and is not an indication of the true relationship. It was questioned by Dockrill (1969) who suggested *Microtis* and *Prasophyllum* could well be placed in different sub-tribes. He is supported by Warcup (1981) whose work with orchid mycorrhiza indicates that the fungal endophytes of *Microtis* and *Prasophyllum* are quite different.

Both *Prasophyllum* and *Microtis* have a single hollow, terete leaf with a terminal raceme of many small flowers, but those of *Microtis* are resupinate whilst those of *Prasophyllum* have the labellum above the column, due to the flower pedicel twisting through a further 180°. The similar appearance of the plants may have resulted from parallel

evolution caused by a similar pollination syndrome, for there are marked differences between column structure of the two, particularly with the species of *Prasophyllum* in the section *Eu-prasophyllum* (see Table 3).

Microtis may be more closely allied with the Australasian genus *Thelymitra* placed by Dressler (1981) in the same tribe *Diurideae* Lindley but in the sub-tribe *Diuridinae* Lindley adjacent to the *Prasophyllinae*. Warcup (1981) has shown that both *Microtis* and *Thelymitra* are symbiotic with the same soil fungus, *Tulasnella calospora* while *Prasophyllum* is associated with *Ceratobasidium* spp. Like *Microtis*, the genus *Thelymitra* has a single leaf arising from an underground tuberoid and in some cases, e.g. *T. antennifera*, *T. cucullata*, the terminal raceme emerges through a fissure in the tubular base of the terete-elongate leaf after the fashion of the *Prasophyllinae* although in *Thelymitra* the leaf is never hollow above the fissure. Unlike *Prasophyllum* the flowers of both *Thelymitra* and *Microtis* are resupinate.

Table 3 below shows similarities and differences of column structure in the three genera.

Table 3. Relationship between *Microtis*, *Thelymitra* and *Prasophyllum*

			Prasophyllum	
Column feature	**Microtis**	**Thelymitra**	**(Micranthum)**	**(Eu-prasophyllum)**
Shape and development	semi cylindrical	semi cylindrical	semi cylindrical	undeveloped
Anther attachment	sessile	sessile	usually stalked	sessile
Anther position in relation to stigma	above	above	above (actually below in the reversed flower)	behind
Pollinia	granular/sectile	granular/mealy	sectile	sectile
Pollinia attachment to viscidium	basitonic, direct or via a short caudicle	basitonic direct or via a short caudicle	mainly basitonic via a stipe or caudicle	terminal via a stipe
Column appendages (shape & size)	simple, obtuse, small	simple, obtuse small to large complex and decorated with hairtufts, crests or tubes	bi- or trilobed large	usually bilobed, small to large

From Table 3 it can be seen that there are significant differences between the column structure of *Microtis* and *Prasophyllum*, particularly of the section Eu-prasophyllum, and there are many similarities between *Microtis* and *Thelymitra*. Yet the flowers of *Microtis* and *Thelymitra* are strikingly different in general appearance. *Thelymitra* has large colourful flowers with the labellum reduced to a simple petal, but this can be attributed to the different pollination syndromes of the two genera (Bates 1983a). I retain *Microtis* in the *Prasophyllinae*, but consider this to be a rather artificial sub-tribe.

Key to Species

1. Labellum without callosities.
    2. Labellum ovate to elliptic, lamina flat, lateral sepals spreading below petals .... 1. *M. atrata*
    2. Labellum orbicular, lamina concave, lateral sepals appressed to the ovary, hidden below labellum .... 2. *M. orbicularis*

1. Labellum with callosities.
    3. Labellum with one or two basal callosities but no apical callus, margins entire or undulate.
        4. Flowers globular, dorsal sepal with 3-5 longitudinal ridges, lateral sepals triangular, much incurved, roots thickened .... 3. *M. globula*

Key to species (continued)

4. Flowers widely expanded, lateral sepals ovate-lanceolate to linear-lanceolate, spreading recurved or revolute, roots not thick.
   5. Labellum ± oblong; lateral sepals ovate-lanceolate, spreading on either side of the labellum, flowers white .... 4. *M. pulchella*
   5. Labellum cordate; lateral sepals linear-oblong, recurved or revolute, flowers green .... 5. *M. parviflora*

3. Labellum with conjoined basal callosities and with an apical callus, margins crenate, crenulate papillose or granular.
   6. Labellum with narrow basal portion expanding into two apical, divaricate lobes, margins undulate, granular, flowers white .... 9. *M. alba*
   6. Labellum oblong, apex obtuse, truncate or emarginate, margins crenate or crenulate, flowers green.
      7. Flowers distant on the spike, dorsal sepal slightly concave below, petals spreading, below dorsal sepal, labellum at least 2/3 as long as the slender, elongate ovary .... 8. *M. rara*
      7. Flowers more or less crowded on the spike, dorsal sepal markedly concave below, petals partly hidden within the dorsal sepal, labellum less than half as long as the turgid ovary.
         8. Flowers numerous, lateral sepals recurved or rolled .... 6. *M. unifolia*
         8. Flowers 1-10, lateral sepals not recurved or rolled .... 7. *M. oligantha*

1. **Microtis atrata** Lindley, Sketch Veg. Swan Riv. Colony, Append. 54 (1840); Lindley, Gen. sp. orchid. pl. 395 (1840); F. Muell., Fragm. Phyt. Aust. 5: 97 (1866); Woolls, Contrib. Fl. Aust. 15 (1867); Benth., Fl. Aust. 6: 347 (1873); Tepper, Trans. Proc. R. Soc. S. Aust. 6: 65 (1883); French, Vict. Nat. 2: 130 (1886); Fitzg., Aust. Orch. unpub. t. col.; R. Rogers in Black, Fl. S. Aust. edn. 1 (1): 136 (1922); Pescott, Orch. Vict. t. opp. p. 49 (1928); Dickins, Vict. Orch. t. 43 (1929); Pelloe, W. Aust. Orch. 20 (1930); Ewart, Fl. Vict. 333 (1931); Nicholls in Barret, Sun Nature Book 5: 16, t. col. (1934); Nicholls, Vict. Nat. 66: 99 Fig. R (1949); Erickson, Orch. West. 48 (1951); Willis, Handb. Pl. Vict. 1: 362 (1963); Firth, Orch. Tasm. 42 (1965); Cady, Aust. Pl. 4: 165 (1967); Nicholls, Orch. Aust. 23, t. 91, col. (1969); A.S. George, Nuytsia 1 (2): 184 (1971); Gray, Vict. Nat. Orch. 2: 8, col. photo (1971); Lothian, Rosa Fiveash Aust. Orch. t. 87 col. (1974); Weber & Bates in J.P. Jessop ed., Black, Fl. S. Aust. edn. 3 (1): 422, t. 400 (1978); W.M. Curtis, Stud. Fl. Tasm. 4a: 56, t. 8 (1980).

Type: *J. Drummond s.n.*, Swan River (Western Australia) 1839 (K-L, holo; K, iso.!).

M. minutiflora F. Muell., Fragm. Phyt. Aust. 1: 90, 244 (1859); Tate, Handb. Fl. extratrop. S. Aust. 164. [Orthographic variants include 'M. minor' F. Muell. Fragm. Phyt. Aust. 5: 235 (1866) and 'M. moutifolia' Lothian, Rosa Fiveash Aust. Orch. 33 (1974).]

Type: *F. Mueller s.n.*, "In planitiebus uliginosis apud, Mt. Abrupt (Victoria)", xi.1853, (MEL 99027, syn.!, K-L iso.); *F. Mueller s.n.*, Glenelg River, xi.1853, (BM, syn.!); *F. Mueller s.n.*, Moe Swamp (Victoria), not seen.

M. atrata var. *viridula* Reichb. f., Beitr. Syst. Pfl. 62 (1871).

Type: *L. Preiss 2403*, Swan River (W, lecto.) [Lectotypified by A.S. George, Nuytsia 1 (2): 184 (1971)]; *F. Mueller s.n.*, Australia felix (W. syn.) not seen. "M. nigrita Lindl.", Sullivan in obs., Wings South Sc. Rec. 3 (9): 217 (1882), is a probable orthographic variant of *M. atrata*.

Plant diminutive, 3-9 cm high, occasionally up to 20 cm if growing in water. *Tuberoid* ovoid, 3-5 x 2-4 mm; epidermis drying white, separating when mature. *Leaf* 3-7 (-15) cm long, 2-3 mm diam.; apex acute ± solid, erect; fissure c. 6 x 1 mm, at swelling in leaf, 2-6 cm from base. *Flowers* almost sessile, 2-40, sometimes fragrant, yellow-green, drying black, erect, thick textured, spirally arranged in moderately dense raceme, 1-3 cm long;

scape <2 cm long, c. 1 mm diam. *Floral bract* ovate, c. 0.5 x 0.4 mm, obtuse or sub-acute. *Dorsal sepal* orbicular to ovate, 1.2-1.5 x 1.2-1.5 mm, with short, depressed, obtuse apex. *Lateral sepals* oblong, 0.8 x 0.2 mm, spreading, slightly concave sub-acute. *Petals* ovate-falcate, 0.6 x 0.2 mm, concave, spreading below dorsal sepal. *Labellum* ovate to elliptic, 0.8-1.0 x 0.6 mm, straight or reflexed against ovary, margins entire; apex rounded, obtuse; lamina without callosities, minutely tuberculate, often with 2-6 longitudinal, granular lines turning black in mature flowers, abaxial side of labellum smooth. *Column* c. 0.6 x 0.3 mm, with prominent ovate-falcate auricles, c. 0.2 x 0.2 mm, arising alongside stigma. *Stigma* semi-lunate, 0.2 x 0.1 mm; rostellum dark green dot in upper border. *Anther* 0.2 x 0.2 mm, about as high as auricles. *Pollinia* granular, connected directly to viscidium. *Ovary* ovoid, larger than flower, c. 2 x 1.5 mm, appressed to or standing out from scape. *Seeds* the smallest in genus. Figs 6A; 8A, B.

Distribution (Map 1)

Restricted to chiefly coastal situations in southern temperate Australia, occurring in the south-west of Western Australia, southern and eastern Victoria, northern Tasmania, islands of Bass Strait and South Australia east from Adelaide.

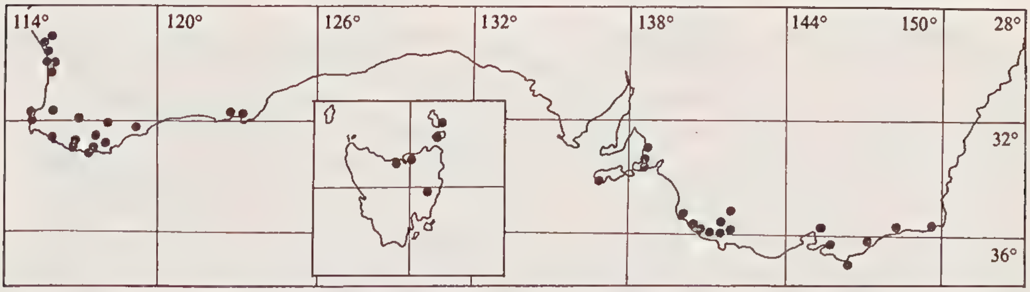
Flowering: September to December.

Ecology: Occurring is swamps or in soil which is very boggy in winter, but which may dry out completely in summer. Often forming dense colonies by vegetative increase. (Fig. 10).

Affinities

Seven years after describing *M. minutiflora*, Mueller (1866) cited the type specimens under *M. atrata* Lindl. Perhaps he was originally misled by the epithet 'atrata', as on a type sheet he wrote the words "viridis non atrata".

Although I have not seen the type of *M. atrata* var. *viridula* Reichb. f., George (1971) in reducing the variety to synonymy, stated that: "The granular surface of the labellum by which the variety was distinguished is typical of the species". Plants from the type collection of *M. atrata* do have labella with granular lines visible through a microscope. *M. atrata* is a very uniform species and cannot readily be divided into forms or varieties.



Map 1. Distribution of *M. atrata*.

The flowers of *M. atrata* are the smallest of any Australian terrestrial orchid. The species is very distinctive, not closely related to any other. It differs from species in the *M. unifolia* complex by having the leaf above the fissure rigidly erect and almost solid. In having a labellum without callosities it is like *M. orbicularis*, but differs from that species in labellum shape, and also in having lateral sepals not hidden below the labellum. *M. atrata* is also the only species which dries black.

Selected specimens (from c. 400 collections examined)

WESTERN AUSTRALIA: *E. Andrews s.n.*, x.1913, Kalamunda (PERTH); *R. Bates 2910*, 22.xii.1982, Walpole (AD); *R. Cranfield 1168*; 7.xi.1979, 7.5 km NE of Byford (PERTH); *A.S. George 6486*, 9.xii.1964, swamp south of Narrikup (PERTH); *A.S. George 9705*, 12.x.1969, Bow River in burnt swamp (MEL); *A.S. George 14998*, 1.xi.1977, Frankland R. (AD, PERTH); *R. Helms s.n.*, 9.x.1897, Pinjarra (PERTH); *G.J. Keighery 328*, 8.x.1974, 10 km north of Cape Arid (AD); *T.B. Muir 4269*, 7.x.1966, Cape le Grande (MEL); *A. Purdie s.n.*, 7.x.1900, Cannington (AD); *P. Wilson 316*, 1.x.1967, Manjimup (MEL).

VICTORIA: *A.C. Beauglehole 34374*, 24.x.1970, north of Mallacoota (MEL); *A.B. Braine s.n.*, 2.xi.1920, Ringwood (MEL 99024); *A.H. Corrick 609B*, 19.xi.1980, Casterton in swamp (AD); *D.L. Jones s.n.*, 9.x.1961, Wartook Reservoir in water (MEL 99026); *I. Morrison s.n.*, 8.xi.1970, Wilson's Promontory in swamps (MEL 99014); *F. Mueller s.n.*, xi.1861, Warrandyte has label "M. minutiflora viridis non atrata" in Mueller's hand. (MEL 99019); *J.H. Willis s.n.*; ix.1932, Wonthaggi (MEL 200982); *J.H. Willis s.n.*, 23.xi.1952, Quail Island in swamp among rushes (MEL 99034).

TASMANIA: *T. Burns s.n.*, 12.xi.1961, Georgetown Aerodrome (HO 37489); *A. Moscal 69*, 5.xi.1979, Bridport west of sewerage plant (HO); *G. Perrin s.n.*, xi.1970, Swansea (NSW 123892); *J.S. Whinray 137*, 26.x.1970, Cape Barren Island (AD, HO); *J.S. Whinray 172*, 27.x.1967, Flinders Is. old tin mine (AD, HO, MEL).

SOUTH AUSTRALIA: *R. Bates 2093*, 20.x.1981, Peter Creek, Kuitpo Forest (AD); *J.B. Cleland s.n.*, 17.xi.1930, Encounter Bay (AD 97148297); *D. Hunt 1646*, 9.xi.1963, Bool Lagoon (AD); *R. Tate s.n.* sub *R.S. Rogers 2178*, 24.xi.1882, Mt. Julian (AD); *J.G.O. Tepper 567*, 8.xii.1903, Square Waterhole (AD, MEL).

2. **Microtis orbicularis** R. Rogers, Trans. & Proc. R. Soc. S. Aust. 31: 63, t. 20, fig. 1 (1907); Some S. Aust. Orch., t. 27 (1909); Trans. & Proc. R. Soc. S. Aust. 44: 329 (1920); in Black, Fl. S. Aust. edn 1 (1): 218 (1922); Nicholls in Barrett, Sun Nature Bk. 1: 23, t. 6. col. (1932); Rupp, Vict. Nat. 62: 68 (1945); Erickson, Orch. West 48 (1951); Willis, Handb. Pl. Vict. 1: 363 (1963); Firth, Nat. Orch. Tasm. 54 (1965); Cady, Aust. Pl. 4: 165 (1967); Nicholls, Orch. Aust. 23, t. 92, col. (1969); Gray, Vict. Nat. Orch. 76, col. photo (1971); A.S. George, Nuytsia 1 (2): 184 (1971); Weber & Bates in J.P. Jessop ed. Black, Fl. S. Aust. edn 3 (1): 422, t. 402 (1978); Bates, J. Nat. Orch. Soc. S. Aust. 2: 3 (1978); W.M. Curtis, Stud. Fl. Tasm. 4a: 56 (1980); Woolcock, Orchadian 6: 100, t. (1980).

Type: *R.S. Rogers 2213*, Myponga Swamp (South Australia), 2.xi.1906 (AD, holo.!, AD!, AK!, BM, NSW!, PERTH!, iso.).

Plant slender, 5-30 cm high, wholly green or variously pigmented with red. *Tuberoid* ovoid, 0.3-0.5 x 0.2-0.3 cm; epidermis white, drying and separating when mature. *Leaf* 5-20 cm long, 2-3 mm diam.; apex acute, ± solid, erect, narrowing abruptly; fissure 6-10 x 2-6 mm, developing at characteristic swelling in leaf. *Flowers* almost sessile, 3-30, not scented, green or red, thick textured, erect, spirally to alternately arranged in moderately loose raceme, 1-5 cm long, higher than leaf apex; free scape < 5 cm long, c. 1 mm diam. *Floral bract* ovate-lanceolate, 2-3 x 1-1.5 mm, acute. *Dorsal sepal* ovate, 1.2-2 x 0.8-1.6 mm, deeply concave, with broad, obtuse, decurved apex. *Lateral sepals* linear, 0.5-1.2 x 0.2-0.4 mm, appressed to ovary, hidden below labellum, sub-acute. *Petals* ovate-lanceolate, 1-2 x 0.6-1 mm, spreading below dorsal sepal; apex incurved, sub-acute. *Labellum* orbicular, 1.3-2.5 x 1.3-2.5 mm, pendulous, fleshy; margins entire; apex obtuse, recurved or decurved; lamina without callosities, smooth, concave, often with small circular pit in centre; nectary obscure, darker hued, glistening, near base. *Column* 0.5-1 x 0.3-0.8 mm with minute, fleshy, conical auricles c. 0.15 x 0.1 mm. *Stigma* ovate, 0.2 x

0.3 mm, concave; rostellum beak shaped, c. 0.2 x 0.1 mm, at right angles to stigma and overhanging. *Anther* c. 0.2 x 0.2 mm, cucullate, retuse, apex higher than auricles. *Pollinia* coherent, caudicle 0.2-0.4 mm (long for the genus); viscidium ovate, minute. *Ovary* ovoid, 2-3 x 1.5-2 mm, erect, standing well out from spike; *Seeds* very pale. (Figs 6B, 8C, D).

Distribution (Map 2)

South-west Western Australia and from eastern Victoria, through Bass Strait islands to Tasmania, and into South Australia as far west as Eyre Peninsula. Mainly coastal.

Flowering: September to December.

Ecology

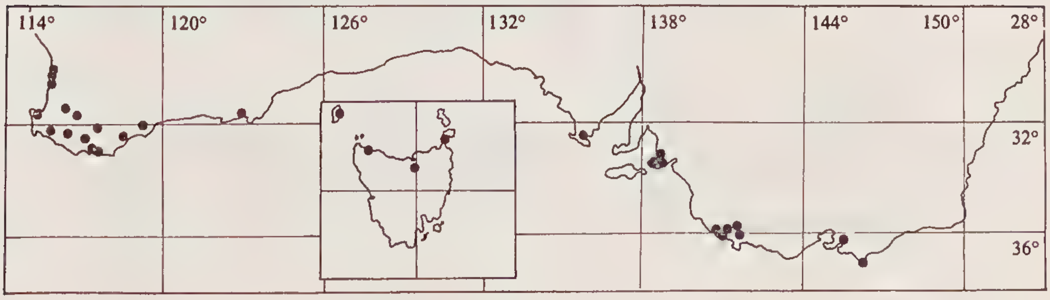
Semi-aquatic or swamp plants often submerged in water to 150 cm deep in winter; elongating in the spring, the flower spike usually opening above the, by then, shallow water. By the time the seed is released some 2-3 weeks after flowering the plant may be in mud only, although following heavy spring rains I have seen the plants flower under water. The seeds are probably transferred from swamp to swamp in mud on the feet of water birds or transported by water flow. Plants occur singly or may be clumped due to vegetative reproduction, the new tubers being produced next to the old ones and, not distant as in other species.

Affinities

Vegetatively *M. orbicularis* is indistinguishable from *M. atrata*. The major difference lies in labellum shape; *M. orbicularis* has an orbicular labellum with concave lamina (Figs 8C, D), *M. atrata* has an ovate to elliptic labellum with a flat lamina (Figs 8A, B). Other differences include flower colour and the larger flower size of *M. orbicularis* which has linear lateral sepals hidden below the labellum in comparison to the spreading, oblong lateral sepals of *M. atrata*. Unlike *M. atrata*, *M. orbicularis* does not dry black. All other species differ in having labella variously adorned with callosities.

Selected specimens (from c. 150 collections examined)

WESTERN AUSTRALIA: *A.S. George s.n.*, 9.xi.1957, Banganup Swamp, Jandakot (PERTH); *A.S. George 9733*, 12.x.1969, Broke Inlet (MEL); *A.S. George 14997*, 1.xi.1977, Frankland River in wet clay by creek (PERTH); *V. Mann and A.S. George 114*, 12.xi.1969, Bow River in burnt swamp (PERTH); *F. Mueller s.n.*, x.1867, Mt. Barker (MEL 99042); *R.D. Royce 4352*, 17.ix.1953, Elgin in clay swamps (PERTH); *O.H. Sargent 1385*, 10.ix.1921, Kenwick & Moora (AD), *D. Voigt s.n.*, x.1979, Cape le Grande (PERTH); *W. Wittwer 1165*, xi.1970, Lake Muir in water (PERTH).



Map 2. Distribution of *M. orbicularis*.

VICTORIA: *J. Anderson s.n.*, xi.1931, Wonthaggi (MEL 99066); *R. Bates 327*, xi.1978, Poolaigelo in shallow lagoon (AD); *A.C. Beauglehole s.n.*, 25.xi.1942, Gorae West (MEL 582288); *A.H. Corrick 609*, 19.xi.1980, Casterton, Glenelg River (MEL); *I. Morrison s.n.*, 8.xi.1970, Vereker Range, Wilson's Promontory (MEL 1514612); *E.M. Tucker s.n.*, 10.xi.1963, Woolpooer, Grampians (MEL 584377).

TASMANIA: *M.J. Firth s.n.*, 6.xii.1964, Rocky Cape in water (MEL 584378); *A. Moscal 68*, 5.xi.1979, Bridport (HO); *J.S. Whinray 135*, 27.x.1973, Cape Barren Island in old quarry (AD, HO, MEL).

SOUTH AUSTRALIA: *R. Bates 2094*, 20.x.1981, Peter Creek Swamps, Kuitpo (AD); *R. Bates 2269*, 23.ix.1982, 10 km east of Wanilla, Eyre Peninsula (AD).

3. **Microtis globula** R. Bates, sp. nov.

Ab *Microtis* speciebus aliis radicibus tumidis succulentis fragilibus et tuberibus minus quam 0.5 cm diametro; floribus globularibus, sepalo dorsali orbiculari, 3-5-porcato, 2.0 x 2.0 mm, sepalis lateralibus triangularibus, c. 2 x 1.2 mm, concavis, multo incurvatis apicibus crassulatis; petalis ovatis, c. 1.4 x 0.8 mm, inclusis a sepalis; labello 1.5-2 mm longo, base suborbiculari, apice oblongo, marginibus integris et callis basalibus connatis rectangularibus; ovario ovoido tumescenti, c. 3.2 x 2 mm; seminibus atrobruneis differt.

Type (Fig. 3): *R. Bates 2922*, 15 km west of Walpole (Western Australia), 22.xii.1982 (AD, holo.; PERTH, iso.).

Plant slender, 18-28 cm high, wholly greenish. *Tuberoid* ovoid, 0.2-0.4 x 0.2-0.3 cm, white; epidermis not separating when dry. *Roots* 3-5, swollen and fleshy, brittle, 1-4 cm long, 0.2-0.4 cm diam. *Leaf* hollow, terete, 8-20 cm long, 0.2-0.4 mm diam.; apex ± hollow, acuminate, erect or drooping; fissure c. 1 cm long forming 2-5 cm from base of leaf. *Flowers* 8-30, not scented, pale or yellow-green, decurved, globular due to incurved sepals, spirally arranged in loose to moderately dense raceme, 2-8 cm long; free scape 5-15 cm long, 0.1-0.2 cm diam. *Pedicel* c. 1 x 0.4 mm. *Floral bract* ovate, 1.5 x 0.8 mm, obtuse. *Dorsal sepal* orbicular to ovate, 2-2.2 x 2 mm, deeply concave below, cucullate, with 3-5 raised longitudinal ridges, apex conical, straight. *Lateral sepals* triangular, 2 x 1-1.2 mm, much incurved with upper margins partly overlapping dorsal sepal, inner surface concave; apex crassulate, sub-acute. *Petals* ovate, c. 1.4 x 0.8 mm, incurved, enclosed within sepals; lower margin sinuate, apex obtuse. *Labellum* 1.5-2 mm long; basal half sub-orbicular, c. 1 mm diam.; apex ± oblong, 0.6-1 x 0.5 mm, broadest distally, obtuse; margins entire, slightly sinuate; basal callus rectangular, 0.8 x 0.9 mm, concave about centre, surface irregular; nectary a transverse depression near base, no apical callus, but a circular, rugulose area 0.2 x 0.2 mm on lamina near apex in many flowers. *Column* c. 0.84 x 0.4 mm with membranous, oblong auricles, c. 0.3 x 0.08 mm, spreading on either side of anther. *Stigma* slightly prominent, semi-lunate, 0.2 x 0.3 mm, rostellum broadly triangular, 0.2 x 0.3 mm, apex becoming emarginate. *Anther* broadly hemispherical, 0.2 x 0.3 mm, cucullate, retuse with minute mucro. *Pollinia* friable, attached directly to ovate viscidium. *Ovary* ovoid, 3-4 x 1.5-2.5 mm, erect but decurved at apex. *Seeds* very dark brown (Figs 3, 6C).

Distribution (Map 3)

M. globula seems to be endemic to an area along the south-west coast of Western Australia from near Albany to west of Walpole, a distance of less than 200 km.

Flowering: December-January.

Ecology

All collections of *M. globula* have been made along swamp margins which had been burnt over in late summer, 9-10 months prior to collecting. The author found the species in damp sand around a *Cephalotus* bog which contained a large population of *M. pulchella*

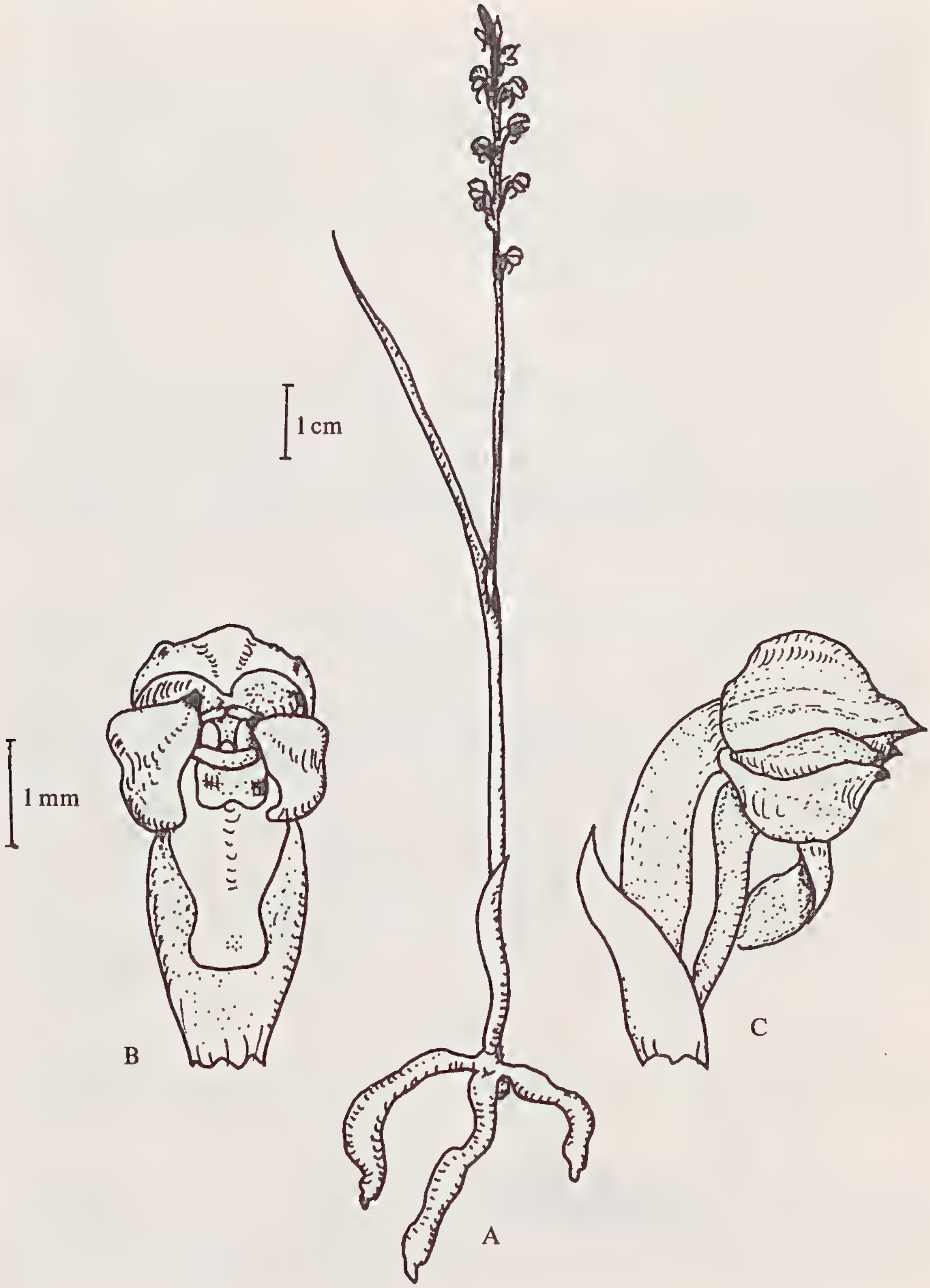


Fig. 3. *M. globula*. A, plant; B, flower in front view; C, flower in side view. (*R. Bates 2922* from near Walpole, W. Australia). Illustration by L. Dutkiewicz.

in flower. Whereas *M. pulchella* grew only in areas of permanently seeping water, the *M. globula* grew where the soil dried out in summer. With R. Heberle of Albany, I had previously visited locations where both *M. pulchella* and *M. globula* had flowered in abundance a year earlier. In these locations the species could be located only from the dried inflorescences of the previous year and much searching was necessary to reveal filiform leaves 1-2 cm long, indicating that both *M. pulchella* and *M. globula* flower only after fires. The restricted environment, the fire stimulated flowering, the late flowering season (December-January) and the small green flowers of *M. globula* would all seem to be reason why the species has only recently been 'discovered'. Heberle (pers. comm. 1982) believes there are other unnamed *Microtis* species occurring in the Albany area, restricted to permanent bogs and seldom flowering.

Affinities

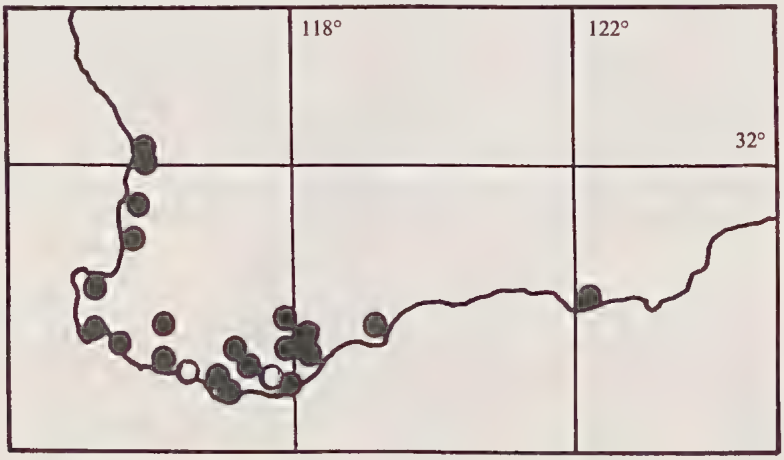
M. globula does not seem to be closely allied to any other species. If the swollen fleshy, brittle roots are a feature of all populations, they alone would set the species apart. The flowers too are very distinctive; the much incurved, triangular, lateral sepals give the flowers the globular appearance which suggested the specific epithet. The ribbing on the dorsal sepal does not occur in any other species and the labellum is distinctive, although most closely allied to that of *M. pulchella* with its basal callus and minute rugulose area near the apex.

Conservation status:

As the known populations are all in conservation parks the species may be considered rare but not endangered.

Specimens examined

WESTERN AUSTRALIA: *R. Bates 2922*, 22.xii.1982, 15 km west of Walpole (AD, PERTH); *R. Bates 2923*, 22.xii.1982, 14 km west of Walpole (AD); *R. Heberle s.n.*, 10.i.1982, 10 km NE of Albany (AD); *H. Webster* sub *R. Bates 2843*, 26.xii.1981, 10 km NE of Albany (AD).



Map 3. Distribution of *M. alba* ● and *M. globula* ○

4. **M. pulchella** R. Br., Prod. 321 (1810); Sprengel. Syst. Veg. 3: 713 (1826); Woolls, Contrib. Fl. Aust. 15 (1867); Reichb. f., Beitr. Syst. Pfl. 62 (1871); Benth., Fl. Aust. 6: 349 (1873); Schltr., Bot. Jahrb. 45: 382 (1911); R. Rogers, Trans. & Proc. R. Soc. S. Aust. 44: 328 (1920); Pelloe, W. Aust. Orch. 20 (1930); Erickson, Orch. West 48 (1951); Cady, Aust. Pl. 4: 167 (1967); A.S. George, Nuytsia 1 (2): 185 (1971); Oliver, Nature Walkabout W. Aust. 12: 64, col. photo 26 (1976).

Type: *R. Brown, s.n.*, King George Sound (W. Aust.) Dec. 1801 (BM, lecto.!, K, iso.!). The sheet at BM bears the information in Brown's hand "Ophrys pulchella, in paludibus ad portum regis Georgiv III Dec. 1801". The lectotype was selected by A.S. George (1971) as holotype.

M. gymnadenioides Diels, J. Muell. Bot. Soc. W. Aust. 1 (2): 79 (1903); R. Rogers, Trans. & Proc. R. Soc. S. Aust. 44: 328 (1920); Pelloe, W. Aust. Orch. 20 (1930); Erickson, Orch. West 49 (1951); Blackall & Grieve, W. Aust. Wildfl. 90 (1954), Cady, Aust. Pl. 4: 167 (1967).

Type: *L. Diels s.n.*, wet sandy flats north of Albany (W. Aust.), xi.1901 (not located).

Plant slender, 10-30 cm high. *Tuberoid* ellipsoid, 0.4-1.0 x 0.3-0.8 cm; epidermis white, peeling free when mature. *Leaf* 6-20 cm long, 0.3-0.6 mm diam., apex acute, ± solid, erect; fissure c. 1 x 0.2 cm, forming 2-8 cm from leaf base. *Flowers* 5-25, lightly perfumed or not, white, thinly textured, at first erect, drooping in older flowers, spirally arranged in loose raceme, 1.5-8 cm long, on free scape 7-14 cm long, only 1-1.5 mm diam. *Pedicel* slender, 0.8 x 0.3 mm. *Floral bract* ovate, 1.5-2 x 1-1.2 mm, acute. *Dorsal sepal* ovate, 2.5-2.8 x 2 mm, almost flat to slightly concave, sub-acute. *Lateral sepals* ovate-lanceolate, 2.2-2.5 x 1-1.2 mm, depressed and spreading on either side of labellum, slightly concave, apex straight or recurved, acute. *Petals* falcate-lanceolate, 2-2.2 x 0.8 mm, flat, spreading widely below dorsal sepal; apex straight, sub-acute. *Labellum* ± oblong, 3-3.5 x 1-1.3 mm, standing out at right angles to ovary, narrowest about middle; margins entire or slightly crenulate near middle; basal calli ovate to orbicular, c. 1.2 x 1.2 mm, green, conjoined, surface smooth with deep V-shaped nectary below two conical protruberances at base; no apical callus but often an irregular rugulose area on lamina near apex; apex downturned, rounded or retuse. *Column* c. 1.6 x 1 mm, with prominent oblong-lanceolate auricles, c. 0.5 x 0.2 mm, spreading at right angles to column. *Stigma* semi-lunate, c. 0.3 x 0.2 mm, 0.8 mm from column foot; rostellum triangular, c. 0.3 x 0.2 mm, widely beaked. *Anther* broad, 0.6 x 0.8 mm, cucullate, retuse with minute recurved mucro. *Pollinia* mealy; caudicle 0.1 mm long; viscidium ovate, 0.1 mm long. *Ovary* elongate, 3-4 x 1-1.5 mm, erect, straight, standing well out from scape. *Seeds* brown. (Figs 2A; 6D; 8E, F).

Distribution (Map 4)

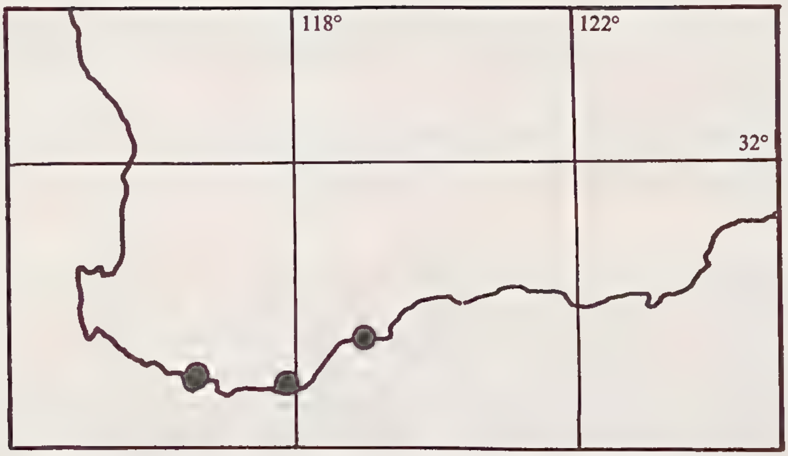
Restricted to a small area in the far south-west of Western Australia from east of Albany to near Pemberton.

Flowering

November to January. In seasons not following fire plants of *M. pulchella* are reduced to filiform leaves only 1-2 cm long (*R. Bates 2927*, AD), or these leaves may be completely absent, the plant being reduced to a subterranean system of tuberoids and rootlets in mycorrhizal association with soil fungi.

Ecology

Occurring only in near coastal swamp, or damp sandy heathlands and generally stimulated to flower by late summer bushfires.



Map 4. Distribution of *M. pulchella.*

Affinities

Diels (1903) stated that *M. gymnadenioides* differed from *M. pulchella* in having a ". . . longer leaf, the dorsal sepal wider and more concave, the crisped margin of the labellum and larger flowers". George (1971) agreed with Schlechter (1911) in treating it as a synonym of *M. pulchella* and he stated "Diels did not see Brown's specimens and his characters for distinguishing *M. gymnadenioides* in fact fall down when a range of specimens is examined." George pointed out that the correct spelling of the epithet is "gymnadenioides" not "gymnadenoides" as used by most authors.

M. pulchella is a very distinct species not closely allied to any other. In general appearance its raceme of delicate, white, widely opened flowers resembles that of *M. alba*, but the latter species has the labellum cuneate with bilobed apex, papillose margins and a large apical callus. The lateral sepals of *M. pulchella* are spreading while those of *M. alba* are revolute. The labellum of *M. pulchella* is like that of *M. globula* and *M. parviflora* in having basal callosities but no apical callus, and all three may have an indistinct rugulose area on the lamina near the apex. *M. globula* differs however in its globular flowers. *M. parviflora* differs in having revolute lateral sepals and both have smaller, greenish flowers and a different labellum shape.

Conservation status

M. pulchella is included by Leigh, Briggs and Hartley (1981) in their list of rare Australian plants. Despite its uncommon nature and restricted distribution it appears to be well conserved.

Specimens examined

WESTERN AUSTRALIA: *R. Bates 2916*, 22.xii.1982, 10 km NW of Walpole (AD, CHR, HO, MEL, NSW, PERTH); *W.E. Blackall s.n.*, xii.1945, Albany (PERTH); *J. Drummond 307*, 1843, South-West Australia (AD, BM, MEL); *A.S. George 6491*, 6.xii.1974, Albany to Bremer Bay (PERTH); *R. Heberle* sub *R. Bates 2128*, 25.xii.1981, Albany area (AD); *J. Tonkinson s.n.*, xii.1968, Albany (PERTH); *J. Tonkinson s.n.*, i.1966, Albany (PERTH).

5. **M. parviflora** R. Br., Prod. 321 (1810); Sprengel, Syst. Veg. 3: 71 (1826); Bauer, in Curtis' Bot. Mag. 62, t. 3377 col. (1835); Endl., Icon. Gen. Pl. t. 15 (1838); Lindley, Gen. sp. orchid. pl. 395 (1840); Benth., Fl. Aust. 6: 349 (1873); F.M. Bail., Syn. Qld. Fl. 520 (1883); French, Vict. Nat. 2: 130 (1886); R. Rogers, Trans. & Proc. Roy. Soc. S. Aust. 37: 128 (1913); Domin, Beitr. Fl. Pfl. Aust. 2: 237 (1915); R. Rogers, Trans. & Proc. Roy. Soc. S. Aust. 44: 326 (1920); R. Rogers in Black, Fl. S. Aust. edn 1 (1): 123 (1922); Pescott, Orch. Vict. 36 (1928); Dickins, Vict. Orch. 42 (1929); Rupp., Orch. N.S. Wales 21 (1930); Ewart, Fl. Vict. 334 (1931); Nicholls, in Barrett, Sun Nature Bk. 5: 16 (1934); Nicholls, Vict. Nat. 66: 90 (1949); Willis, Handb. Pl. Vic. 1: 364 (1963); Firth, Nat. Orch. Tasm. 54, t. 3 (1965); Cady, Aust. Pl. 4: 164 (1967); Dockr., Aust. Indig. Orch. 23, t. 94 col. (1969); Burbidge & Gray, Fl. A.C.T. 116, t. 112A (1970); Moore & Edgar, Fl. N. Zeal. 2: 153 (1970); Cady & Rotherham, Aust. Nat. Orch. 22, col. photo (1970); A.S. George, Nuytsia 1 (2): 155 (1971); D.L. Jones, Ann. Bot. n.s. 39: 585 (1975); D.L. Jones, Orchadian 5: 83 (1976); Lavarack, Orchadian 5: 65 (1976); Weber & Bates in J.P. Jessop ed., Black, Fl. S. Aust. edn 3 (1): 423, t. 403 (1978); W.M. Curtis, Stud. Fl. Tasm. 4a: 56 (1980); Beadle et al., Fl. Sydney Reg. 568 (1982).

Type: *R. Brown s.n.*, Port Jackson (New South Wales) 1803-5 (BM lecto.!, K!, AD!, iso? syn.). The smallest plant on the sheet at BM is here selected as lectotype as it is closest to Brown's original description.

M. viridis F. Muell., Fragm. Phyt. Aust. 5: 97 (1865), nom. illeg., pro. parte. The name was used by Mueller to include *M. media* R. Br., *M. parviflora* R. Br., *M. rara* R. Br., *M. arenaria* Lindley and *M. frutetorum* Schltdl.

M. benthamiana Reichb. f., Beitr. Syst. Pfl. 24 (1871); Maiden, Proc. R. Soc. N.S. Wales 60: 130 (1908).
Type: *R. Brown s.n.*, Sydney, ix.1803 (W holo.!, K iso.!).

M. parviflora var. *densiflora* auctt. non Benth. sensu R. Rogers, Trans. Proc. R. Soc. S. Aust. 37: 129 (1913); Nicholls, Vict. Nat. 66: 91 (1949) as "M. parviflora var. densiflora Rogers" in obs. (Based on plants of *M. parviflora* with very crowded flower spikes from Myponga, S. Australia i.e. *R. Rogers 2225* AD).

M. porrifolia var. *parviflora* (R. Br.) Rodway, Tasm. Fl. 195 (1903). Based on *M. parviflora* R. Br.

M. bipulvinaris Nicholls, Vict. Nat. 66: 92, figs. A, F (1949); Willis, Handb. Pl. Vict. 1: 362 (1963); Firth, Nat. Orch. Tasm. 54 (1965); Cady, Aust. Pl. 4: 162 (1967); Nicholls, Orch. Aust. 24, t. 95 col. (1969); Gray, Vict. Nat. Orch. 2: photo 7 (1971); Beadle at al., Fl. Sydney Reg. edn 3: 568 (1982).
Type: *P. Morris s.n.*, Quail Island, Westernport Bay (Victoria), ix.1943 (MEL 70474, holo.!).

M. holmesii Nicholls, Vict. Nat. 66: 94, figs. G, E (1949); Willis, Handb. Pl. Vict. 1: 363 (1963); Cady, Aust. Pl. 4: 164 (1967); Nicholls, Orch. Aust. 2, t. 93, col. (1969); Gray, Vict. Nat. Orch. 2: 1 (1971).
Type: *N. Holmes s.n.*, Moe (Victoria) "Along the railway enclosure on the western outskirts of town", xi.1946 (MEL 70479, holo.!).

Plant slender to robust, 8-40 (-50) cm high. *Tuberoid* globose, 0.5-1 cm diam.; epidermis drying brown and not separating. *Leaf* 10-40 cm long, 3-8 mm diam., apex acuminate, ± hollow, erect or drooping, usually damaged; fissure 1-2 cm long, forming 5-15 cm from leaf base. *Flowers* (10-) 20-50 (-80), rarely scented, green, sub-erect, spirally arranged in moderate to very dense raceme, 3-10 cm long; free scape 3-12 cm long, 1-2 mm diam. *Pedicel* slender or thick, 0.5-1.5 mm long. *Floral bract* ovate, acuminate 3-4 x 2 mm. *Dorsal sepal* orbicular to ovate, 1.5-2.2 x 1.2-2 mm, markedly concave below, apex acute, straight or recurved, usually with small apiculus. *Lateral sepals* linear-oblong, 1.2-2 x 0.8 mm, sub-acute, at first deflexed, becoming recurved or with age. *Petals* falcate-lanceolate, 1-1.5 x 0.3-0.5 mm, sub-acute, partly hidden within dorsal hood. *Labellum* ± cordate (0.8-) 1-1.8 (-2) x 0.3-0.8 mm, decurved through semi-circle; margins entire, sometimes undulate, apex rounded or acute, with short, decurved apiculus; basal calli ovate, c. 0.1 x 0.1 mm, dark green, smooth, conjoined or surrounding small pouch which forms

bulge on underside of labellum; nectary a "W" shaped furrow at base; labellum lamina minutely tuberculate, often with a minute rugulose patch toward apex which is not raised in live material, often drying as a raised area. *Column* 1-1.2 x 0.8 mm, with oblong white-tipped auricles, 0.2 x 0.1 mm. *Stigma* semi-lunate, c. 0.3 x 0.2 mm, becoming convex; rostellum obscurely triangular, 0.2 x 0.1 mm. *Anther* c. 0.2 x 0.1 mm, cucullate, retuse. *Pollinia* at first coherent, soon becoming friable, caudicle c. 0.1 mm at first, contracting as it dries; viscidium orbicular, minute. *Ovary* ovoid, larger than flower, 2-5 x 1.5-3 mm, erect but standing well out from spike on some plants. *Seeds* dark brown. (Figs 4, 7A, 8G, H).

Distribution (Maps 5, 6)

Widespread but mainly coastal, from central eastern Queensland through New South Wales, Victoria and Tasmania, and as far west as the Flinders Ranges in South Australia; also in New Zealand and probably New Caledonia and eastern Asia but specimens not seen.

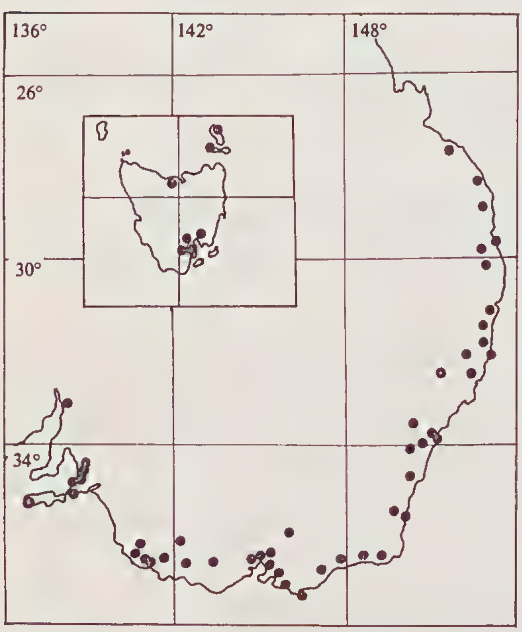
Flowering: Spring and summer.

Ecology

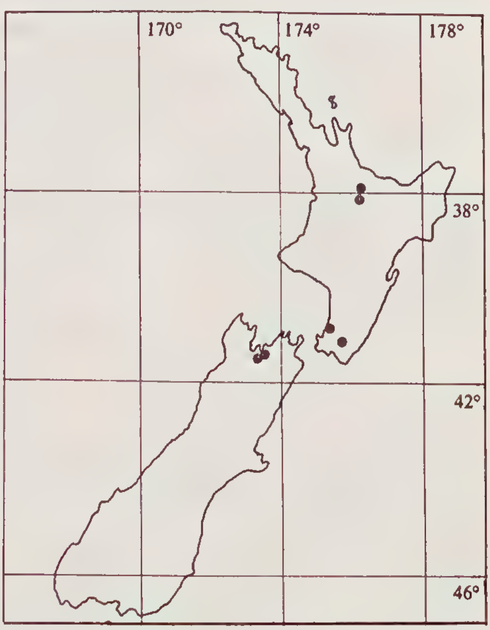
Generally occurring on bogs or damp grassland where it forms extensive, open colonies. Also found in cleared farmland in short pastures, where it is more persistent than other orchids. Rapidly colonises disturbed ground in wet places.

Affinities

M. parviflora is closely related to *M. unifolia*, especially to small-flowered forms. The two species are usually inseparable on a basis of vegetative material; both may be slender or robust plants with flowers moderate to very dense on the spike. In Australia however, plants with small flowers most likely belong to *M. parviflora* and plants with large flowers



Map 5. Distribution of *M. parviflora* in Australia.



Map 6. Distribution of *M. parviflora* in New Zealand.

will usually be *M. unifolia.* The dorsal sepal, lateral sepals, petals and their relative positions are very similar in both species. The most contant differences lie in labellum structure. (Figs 8G, 9A). The labellum of *M. parviflora* is cordate, the margins entire with an apiculus, and the lamina without an apical callus, whereas the labellum of *M. unifolia* is oblong, the margins crenulate, the apex truncate to bifid, the lamina with a large apical callus. *M. parviflora* is frequently pollinated by ants, *M. unifolia* by wasps. Poorly pressed material of *M. parviflora* may be difficult to identify as the labellum wrinkles and loses its shape, in which case boiling the flowers may be necessary to allow a positive identification. Fig. 4 indicates the similarity of the labellum shape in *M. parviflora* from Australia and *M. unifolia* from the Asian and Polynesian regions.

Both *M. bipulvinaris* and *M. holmesii* were described in 1949 from Victorian material. Willis (1953) wrote of the first: "I am inclined to regard *M. bipulvinaris* as a development of *M. parviflora*". Jones (1976) reduced it to synonymy with *M. parviflora.* Nicholls' illustrations (1949, 1969) of this species clearly show it to be a form of *M. parviflora.* Jones (1976) also reduced *M. holmesii* to a synonym of *M. parviflora*, stating that, " . . . the rolling of the lateral sepals (of *M. holmesii*) is a variable feature but is related to the age of the flowers and hence is an unreliable character." Older flowers of *M. parviflora* generally possess rolled lateral sepals, the main feature by which Nicholls distinguished *M. holmesii.* Nicholls' illustrations of *M. holmesii* (1969, t. 93) indicate the presence of a minute callus near the labellum apex and this feature, although unusual in *M. parviflora*, was not present on all the type specimens of *M. holmesii*; consequently there appears to be no reason to regard *M. holmesii* as a distinct taxon.

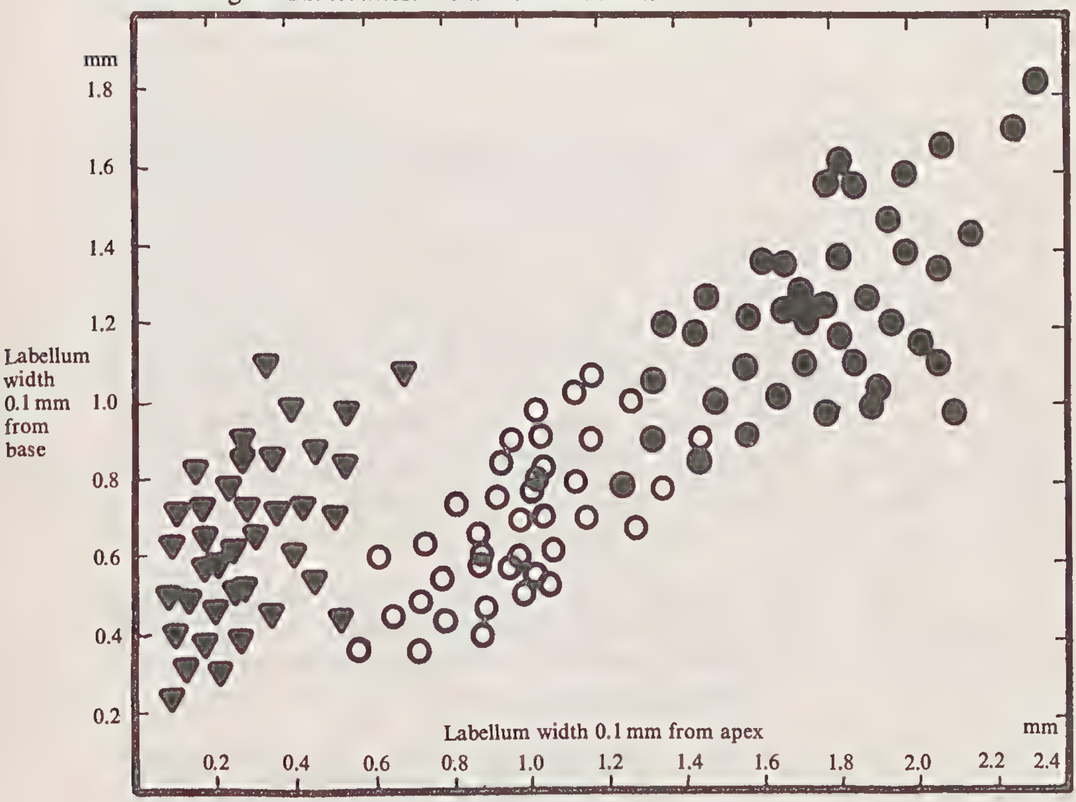


Fig. 4. Scatter diagram portraying the variation of the width of the labellum as measured at the base and at the apex in *M. parviflora* and *M. unifolia. M. parviflora* ▼; *M. unifolia* of Australian and New Zealand populations ●; of Asian and Polynesian populations O.

Selected specimens (from 320 collections examined)

QUEENSLAND: *W. Abell s.n.*, 7.ix.1965, near Maryborough (NSW 123844); *F.M. Bailey s.n.*, 1888, no locality (AUK 96162); *R. Fitzgerald s.n.*, 1876, McLeay River (MEL 99107); *E.H. Ising s.n.*, 16.viii.1969, Caloundra (AD 97013191): *F.H. Kenny s.n.*, ix.1908, Gympie (AD 97734717); *F. von Mueller s.n.*, date unknown, Moreton Bay (MEL 99093); *J.H. Simmonds s.n.*, 2.ix.1938, Tambourine Mtn. (CHR 14365).

NEW SOUTH WALES: *B. Briggs 3063*, 17.x.1974, Central West Slopes (NSW); *J.B. Cleland s.n.*, 6.x.1911, Narrabri (AD 97735054); *R. Coveny 4500*, 7.x.1976, Jenolan Caves (NSW); *M. Fagg 309*, 28.xii.1966, 90 km east of Albury (AD); *M. Fawcett 8*, 7.xi.1970, Bullahdelah (MEL 99102); *J.H. Maiden s.n.*, 17.x.1880, Port Jackson (NSW 88270); *T.B. Muir 1708*, 10.xi.1974, Mitta Mitta (MEL); *H.M.R. Rupp s.n.*, x.1927, Paterson (NSW); *F.A. Rodway s.n.*, 20.x.1929, Jervis Bay (OA 41707, K).

VICTORIA: *A.C. Beauglehole 30105*, 17.xii.1976, Marlo (MEL, AD); *A.B. Braine s.n.*, 23.x.1921, Athlone (AD 30368); *K. Czornij 477*, 9.xii.1971, Genoa (AD); *F. Mueller s.n.*, 16.xi.1880, Horsham (MEL 99119); *F. Mueller 65*, Coll. G.A. Toepffer, 3.xii.1886 (MEL); *R. Nash 474*, 8.i.1956, Somers (AD); *W. Perry s.n.*, 7.xi.1907, Bendigo (MEL 538337); *E.E. Pescott s.n.*, 16.xi.1917, Fern Tree Gully (AD 97730372); *J.H. Willis s.n.*, 6.i.1966, Mt. Donna Buang (MEL 584371).

TASMANIA: *E.W. Ashby s.n.*, i.1913, Sandford Bay (AD 97263015); *J.S. Whinray 242*, 29.xii.1968, Deal Island near Lighthouse (HO); *S.A. White s.n.*, xi.1906, Mt. Wellington (AD 97632450).

SOUTH AUSTRALIA: *R. Bates 137*, 25.ix.1968, 3 km west of Alligator Gorge (AD); *R. Bates 2127*, 25.xi.1981, Peter Creek swamps, Kuitpo (AD); *H. Goldsack 477*, 9.x.1932, Cherry Gardens (AD, NSW); *D. Hunt 1448*, 9.xii.1962, Naracoorte (AD); *R.H. Kuchel 1478*, 30.xi.1963, Mt Compass (AD); *R.S. Rogers 2228* 15.xii.1920, Mt Compass. (This is labelled 'M. parviflora var. densiflora' by Rogers) (AD); *A. Spooner 6250*, 7.xii.1974, Tanunda (AD).

NEW ZEALAND: *H. Carse 556*, 24.xii.1911, Manganui (CHR); *A.P. Druce s.n.*, xi.1975, Nelson (CHR 285796); *R. Mason and N. Moar 7016*, 7.xii.1972, Waikato (CHR); *H.B. Matthews 3451*, i.1920, Rotorua (AD); *O. Oswald s.n.*, 17.xii.1924, Wangaramino (CHR 83946); *W.R. Sykes 76*, 24.xi.1970, Macauley Isl. (AUK).

6. **Microtis unifolia** (Forster f.) Reichb. F., Beitr. Syst. Pfl. 62 (1871); Fitzg., Aust. Orch. 2 (1) t. col. (1884); Kraenzl., Bot. Jahrb. Syst. 6: 55 (1885); J.J. Smith, Orch. Java 6: 47 (1905) and Java. Fig. Atlas t. 26 (1908); Ames, Orch. Fasc. 1: 65 (1905) and ibid. 2: 41 (1908); Merrill, Phil. Fl. Pl. 1: 261 (1924); Dickins, Vict. Orch. t. 42 (1929); Black, Fl. S. Aust. edn 2 (1): 217 (1944); Nicholls, Vict. Nat. 66: 93, fig. M. (1949); Erickson, Orch. West 47 (1951); Willis Handb. Pl. Vict. 1: 363 (1963); Firth, Nat. Orch. Tasm. 54 (1965); Jisaburo, Fl. Jap. 340 (1965); Cady, Aust. Pl. 4: 163, fig. B (1967); Backer & Bakhuizen, Fl. Java 3: 254 (1968); Dockr. Aust. Indig. Orch. 1: t. opp. p. 90 (1969); Nicholls, Orch. Aust. 23, t. 96, col. (1969); Moore & Edgar, Fl. N. Zeal. 2: 153 (1970); Burbidge & Gray, Fl. A.C.T. 116 (1970); Gray, Vict. Nat. Orch. t. 2, col. (1972); Pocock, Ground Orch. Aust. col. photos 86, 88 and 89 (1972); Garay & Sweet, Orch. S. Ryuku Is. 42 (1974); Lothian, Rosa Fiveash Aust. Orch. 7, t. 87, col. (1974); Halle, Fl. Nouv. Caled. 8: 469 (1977); Shun Ying, Indig. Orch. Taiwan 1: 482 (1977); Lin, Fl. Taiwan 1062 (1978); Weber & Bates in J.P. Jessop ed. Black, Fl. S. Aust. edn. 3 (1): 423, t. 404 (1978); W.M. Curtis, Stud. Fl. Tasm. 4a: 56 (1980); Cooper, N. Zeal. Nat. Orch. fig. 33 (1981); Cunningham et al., Plants of Western N.S. Wales 200, col. photo (1982).

Type: *Forster 167*, New Zealand, no date (GOET, lecto, photo!, P, iso., photo!). (There is a Forster painting of this species at BM labelled "Charlotte Sound"). The lectotype was selected by A.S. George 1971 as holotype. It is the better of the two type specimens located.

Ophrys unifolia Forster f., Prod. 59 (1786); R. Br., Prod. 320 (1810).

Epipactis porrifolia Sw., Vetensk. Akad. Handl. 21: 233 (1800); Willd., Spec. Pl. 4: 89 (1805); Pers., Synops. Pl. 2: 513 (1807); R. Br., Prod. 320 (1810). Superfluous name based on the type of *Ophrys unifolia*. There is a sheet in the Swartz Herbarium at S without locality, date or collector which may be a type.

Serapias porrifolia (Sw.) Steudel, Nom. bot. 1 (1): 767 (1824); Steudel, Nom. bot. 2 (2): 567 (1841); Heynhold, Nom. bot. Hort. 2 (2): 408 (1846) attributed to Willd.

Microtis porrifolia (Sw.) R. Br. ex Sprengel, Syst. Veg. 3: 713 (1826); Lindley, Gen. sp. orch. pl. 54 (1840); Hook. f., Fl. N. Zel. 67 (1853); F. Muell., Veget. Chatham Is. 43 (1864); Hook. f., Handb. Fl. N. Zel. 266 (1864); Tepper, Garden & Field 5: 100 (1880); F. Muell., Syst. Census Aust. Pl. 112 p.p. (1882); F.M. Bail., Synops. Qld. Fl. 177 (1883); Fitzg., Aust. Orch. 2, t. col. (1884); Rodway, Tasm. Fl. 166 (1903); J.J. Smith, Fl. Buitenz. 6: 47 (1905); Cheeseman, Man. N. Zeal. Fl. 673 p.p. (1906); Laing & Blackwell, Pl. N. Zeal., t. opp. p. 114 (1906); R. Rogers, Trans. & Proc. Roy. Soc. S. Aust. 44: 326 (1920); R. Rogers, in Black Fl. S. Aust. edn. 1 (1): 123, t. 88 (1922); Pescott, Orch. Vict. 47 (1928); Pelloe, W. Aust. Orch. 18 (1930); Rupp, Orch. N.S. Wales 21 (1931); Ewart, Fl. Vict. 245 (1931); Goldsack, S. Aust. Naturalist. 22: 94 (1944).

Microtis media R. Br., Prod. 321 (1810); Sprengel, Syst. Veg. 3: 713 (1826); Lindley, Gen. sp. orchid pl. 396 (1840); F. Muell., Sec. Syst. Census Aust. Pl. 190 (1889); Constantin, Atlas Orch. Cult. t. 28, fig. 1 (1913); R. Rogers, Trans. & Proc. R. Soc. S. Aust. 44: 326 (1920); Pelloe, W. Aust. Orch. 19 (1930); Erickson, Orch. West 48 (1951); Cady, Aust. Pl. 4: 165 (1967); A.S. George, Nuytsia 1 (2): 184 (1971).

Type: *R. Brown s.n.*, King George Sound (Western Australia) Dec. 1801 (BM, lecto., iso.!). The lectotype was selected by A.S. George (1971) as holotype.

M. parviflora auctt. non R. Br. (1810); Ames, Orch. Fasc. 2: 41, quoad syn. (1908); Pelloe, W. Aust. Orch. 19 (1930); Erickson, Orch. West 48 (1961); van Steenis, Mount. Fl. Java 176 (1972); These are references to Western Australian and Asian plants.

M. pulchella auctt. non R. Br. (1810); Lindl. Gen. sp. orch. pl. 396 pp. (1840); Archer & Fitch in Hook. f., Fl. Tasm. 2: t. 118 (1860); Reichb. f., Beitr. Syst. pfl. 62 as "M. pulchella Hook. f." quoad syn. (1871).

M. rara auct. non R. Br. (1810); Benth., Fl. Aust. 6: 347 quoad syn. *M. porrifolia* (1873).

M. banksii Hook., Curtis' Bot. Mag., sub t. 3377 (1835); Hook. f., Fl. N. Zel. 1: 245 (1853); Hook. f., Handb., Fl. N. Zel. 2: 266 (1864); Cheeseman Man. N. Zeal. Fl. 673 as "*M. banksii* A. Cunn." quoad. syn. *M. porrifolia* (1906).

Type: *A. Cunningham 311*, New Zealand "on the slopes of hills among ferns", 1834. (K, holo!, BM, iso!, drawings).

M. pulchella var. *vivax* Lindley, Gen. p. orch. pl. 395 (1840); Reichb. f., Beitr. Syst. Pfl. 62 as "M. vivax R. Gunn" quoad syn. *M. unifolia* (1871).

Type: *R. Gunn 918*, Circular Head (Tasmania), xi.1837 (K-L, syn., photo!); *R. Gunn 915*, Insula van Diemen xi.1837 (BM, syn.!). This sheet bears the label 'M. vivax R. Gunn'.

M. arenaria Lindley, Gen. sp. orch. pl. 396 (1840); Archer & Fitch in Hook. f., Fl. Tasm. 2, t. 118 (1860).

Type: *Gunn 916*, Circular Head (Tasmania) "in sandhills near the sea" 25.ii.1837 (K-L, holo.; AD!, HO!, K!, NSW iso.!).

M. frutetorum Schltdl., Linnaea 20: 568 (1847); Reichb. f., Walp. Ann. bot. 1: 807 (1849): French, Vict. Nat. 2: 130 as "M. frutelorum" quoad syn. M. porrifolia (1886).

Type: *H. Behr s.n.*, pine forest by Gawler Town (South Australia), x. 1846 (HAL, holo.!; K-L, MEL, iso.!).

M. javanica Reichb. f., Bonpl. 5: 36 (1857); J.J. Smith, Bull. Jard. Bot. ser. 3, (10): 4 (1928).

Type: *Reichenbach 859*, Tennger, Java "In graminosis montis Jdjn 6000 feet, 28.iv.1845 (W, holo. photo!).

M. viridis F. Muell., Fragm. Phyt. Aust. 5: 97, nom. illeg. p.p. (1866); Woolls. Contrib. Fl. Aust. 15 (1867).

Type: not known.

M. parviflora var. *densiflora* Benth., Fl. Aust. 6: 348 (1873).

Type: *Drummond 117*, S.W. Australia, 1849 (K, holo.!, MEL, iso.!).

M. longifolia Colenso, Trans. N. Zeal. Inst. 17: 247 (1885).

Type: *W. Colenso*, Norsewood, Hawkes Bay, North Island (New Zealand) 1883-4 (WELT 24277 holo.!, AK 3452 iso.!).

M. papillosa Colenso, Trans. N. Zeal. Inst. 18: 268 (1886).

Type: *C.P. Winkelmann*, Kaipara Heads, North Island (New Zealand) x.1884 (not loc.).

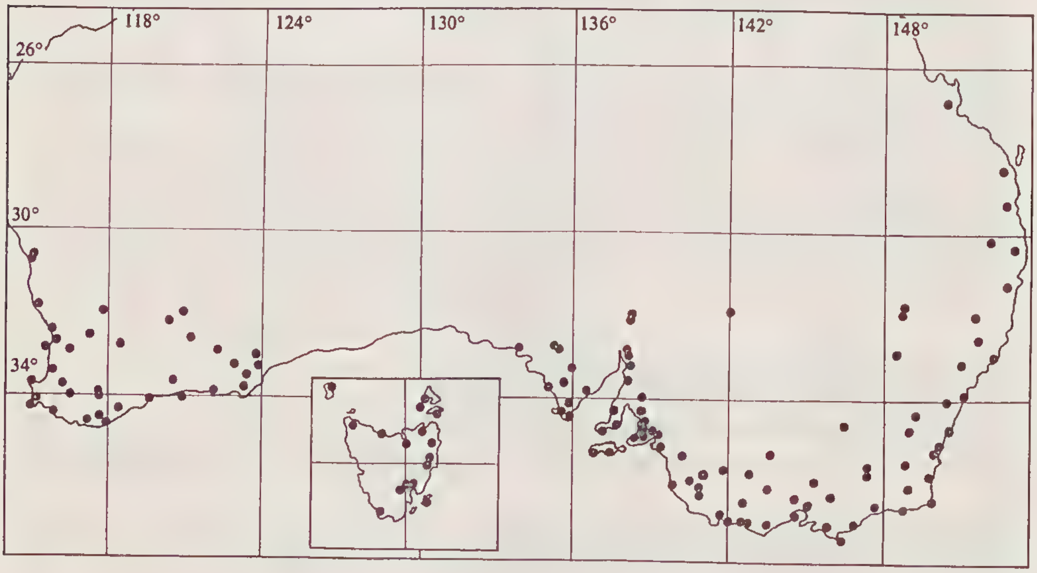
M. aemula Schltr., Bot. Jahrb. Syst. 39: 37 (1906); Rendle, J. Linn. Soc. Bot. 45: 172 (1914); Guillaumin, Bull. Soc. Bot. Fr. 5: 399 (1929); Guillaumin, Fl. Nouv. Caled. 71 (1948).

Type: *R. Schlechter 14724*, "Auf den Hugeln bei Yaouhe" New Caledonia, ix.1902 (P, lecto.; AD!, AK!, BRIS!, K!, NSW!, Z, iso.). Lectotypified by Halle (1977).

M. biloba Nicholls, Vict. Nat. 66: 94, figs. j, 1 (1949); Firth, Nat. Orch. Tasm. 54 (1965); Cady, Aust. Pl. 4: 274 (1967); Nicholls, Orch. Aust. 24, t. 97 col. (1969); Gray, Vict. Nat. Orch. photo. 3 (1972); W.M. Curtis, Stud. Fl. Tasm. 4a: 56 (1980).

Type: *N. Holmes s.n.*, Moe (Victoria) 1946 (MEL 70476, holo!).

Plant slender to robust, 5-60 (-90) cm high. *Tuberoid* globose, 0.5-1.5 cm diam.; epidermis drying brown and not separating. Leaf 8-60 (-80) cm long, 2-12 mm diam.; apex acuminate, hollow, erect or drooping, usually damaged; fissure developing 2-20 cm from leaf base. *Flowers* 6-100 (-150), often lightly scented, green or yellow-green, sub-erect, spirally arranged (rarely in whorls) in moderate to densely packed raceme, 2-20 cm long, to 3 cm diam.; scape from fissure to lowest flower 2-20 cm long, 1-3 mm diam. *Pedicel* 1-1.5 x 0.2-1 mm. *Floral bract* lanceolate to ovate-lanceolate, acuminate, 2-4 x 1-1.5 mm. *Dorsal sepal* ovate to orbicular, 2-4 x 1-2 mm, markedly concave below, apex broad and obtuse to acute, often with short, straight or recurved apiculus. *Lateral sepals* linear-oblong to ovate-lanceolate, 1.5-2.5 x 0.8-1.2 mm, recurved or rolled, sub-acute. *Petals* falcate-lanceolate to ovate-lanceolate, 1.4-1.8 x 0.4-0.8 mm, spreading but partly within dorsal hood, sub-acute. *Labellum* oblong, 1.2-2.5 x 0.4-2 mm, pendulous or recurved against ovary; margins undulate, crenulate to rugulose, apex obtuse, truncate or usually emarginate; basal calli saddle-shaped, 0.2-0.8 x 0.2-0.4 mm, smooth, rounded or square; nectary a 'W' shaped transverse groove at base; apical callus irregular, 0.2-0.4 mm diam., verrucose or papillose, remainder of lamina minutely tuberculate. *Column* 1.2-1.5 x 0.6-0.8 mm, erect or decurved with ovate auricles 0.2 x 0.2 mm. *Stigma* prominent, semi-lunate, 0.2 x 0.3 mm, at first concave, becoming convex, tuberculate and with indistinct margins; rostellum triangular, c. 0.2 x 0.1 mm, erect, bifid. *Anther* 0.2 x 0.25 mm, cucullate, erect at first, becoming decurved, retuse with minute mucro at anthesis. *Pollinia* coherent at first, enclosed in anther cells becoming granular and separating, caudicle c. 0.1 mm long. *Ovary* ovoid, 2-10 x 1.2-3 mm, erect, standing out from scape. (Figs 4, 5, 7B, 9A, B).



Map 7. Distribution of *M. unifolia* in Australia.

Distribution (Maps 7, 8 and 11)

Widely and commonly distributed from the south-west of Western Australia, through southern South Australia, Tasmania, Victoria, New South Wales, eastern Queensland into the tropics, to Lord Howe and Norfolk Islands, New Zealand and its outlying islands, New Caledonia, Indonesia, the Philippines, Taiwan and the Ryukyu Islands to Japan, making it the most widespread orchid of probable Australian origin. The species is unusual among Australian terrestrial orchids in occurring on numerous small off-shore islands.

Flowering

Spring and summer in temperate regions but may flower at any time in the tropics.

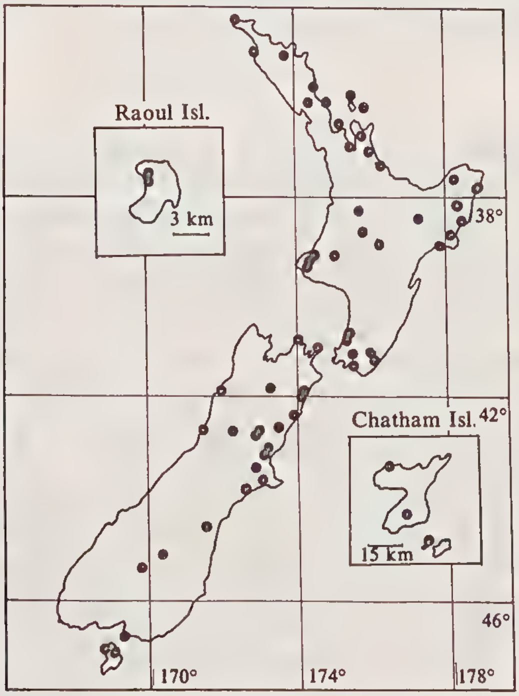
Ecology

Occurs in a wide variety of habitats from littoral to sub-alpine, from swamp and creek-bank to rock outcrops in semi-arid areas, from dense forest to open grassland. One of the few orchids tolerant of saline soils. Forms quite extensive colonies over wide areas. Commonly germinates in disturbed areas i.e. quarries, abandoned gardens, lawns (Garnet 1980, Bates 1981b).

Vernacular name: common onion orchid (Willis, 1963).

Affinities

M. unifolia is closely allied to *M. parviflora* and *M. rara*, in flower morphology, lying somewhat intermediate between the two. All three are inseparable using vegetative material alone, but each can be recognised on the basis of labellum structure and length. In Australia the flowers of *M. unifolia* are larger than those of *M. parviflora*, but the Asian



Map 8. Distribution of *M. unifolia* in New Zealand and outlying islands.

and Polynesian plants (Map 11) of *M. unifolia* can be seen as a connecting link (Fig. 4). *M. unifolia* and *M. rara* are pollinated by small wasps, and the larger more ornate labellum in those species acts as a landing platform for these flying insects. *M. parviflora* is ant pollinated and its smaller, less ornate labellum, is a possible result of such a pollination syndrome. For further differences see discussion under *M. parviflora* and *M. rara.*

Discussion of synonyms

M. aemula Schltr. from New Caledonia is a plant somewhat intermediate between *M. unifolia* and *M. parviflora* (see Fig. 4D), but I follow Halle (1977) in treating it as a synonym of the former.

M. parviflora var. *densiflora* Benth. is a littoral form of *M. unifolia*, with dense racemes, common in coastal dunes. The flower morphology is similar to that of *M. unifolia* and I agree with George (1971) in treating them as synonyms.

M. biloba Nicholls: the bilobed or emarginate labellum (Fig. 4A, B, C) by which Nicholls distinguished *M. biloba* is a feature of *M. unifolia* and I follow Jones (1976) in making the forms synonymous.

M. media R. Br. falls within the range of variation of *M. unifolia*. Brown's original description does not differ in any salient point from Forster's and examination of the types confirms that they should be regarded synonymous.

Brown (1810) in the protologue of *Microtis* remarked that *Epipactis porrifolia* Sw. based on *Ophrys unifolia* Forster f. belonged to this genus without making the transfer of names. Sprengel (1826) made the combination as "*Microtis porrifolia* R. Br.". The correct name and citation for the synonym should be *M. porrifolia* (Sw). R. Br. ex Sprengel. It was not until 1871 that Reichb. f. made the combination *M. unifolia.* He did not attribute the name to Brown: therefore the citation for the species is *M. unifolia* (Forster f.) Reichb. f., the citation most consistently used by recent authors.

Morphology

M. unifolia is very variable in its vegetative and floral characteristics, particularly in size of plants, density of flowers on the raceme and in morphology of the dorsal sepal and labellum (Fig. 4). This is thought to be partly due to the wide geographical distribution, diverse habitats and the influence of other species through hybridisation. Both variable and uniform populations occur and the various forms are not usually confined to a particular area but occur to different degrees in both remote and neighbouring populations. These 'races' interbreed wherever their geographical ranges overlap and their ecological niches are in close proximity, depending on the amount of outcrossing possible between the sympatric populations. Some forms are known to be clonal in nature due either to vegetative reproduction or to apomixy, while others appear to be ecotypic in character. One race from peaty bogs in the Mount Lofty Ranges, South Australia (*Bates 2381*, AD) has a consistently broad orbicular dorsal sepal with an obtuse apex and a fleshy labellum with oblong calli (Fig. 4E). The flowers are similar to *M. oligantha*, but 20-40 occur on each raceme. This form seldom intergrades with others in the same area. Another race occupying swamps in Western Australia (*Bates 2940* AD) has a very narrow acute dorsal sepal with a long apiculus, and a slender labellum with almost entire margins (Fig. 4F). This form has apparently been mistaken for *M. parviflora* in Western Australia. A littoral form common around the coasts of Southern Australia forms very large racemes with densely packed flowers: *Bates 2892*, (AD, PERTH) has racemes with 150 flowers set almost in whorls. The type collection of *M. parviflora* var. *densiflora* Benth. belongs to this form. Populations however are not constant enough to warrant varietal rank.

The most perplexing variation occurs in the eastern Pacific from New Caledonia through Indonesia and the Philippines to Japan. Most plants from these areas have flowers smaller than the average Australian and New Zealand material (Figs 4D, 5), and do not possess the emarginate apex to the labellum which is a common feature of these plants. In general the apical callus of the Asian and near Asian plants is much smaller than in Australian and New Zealand populations, yet in some collections (i.e. *Hoogland 7462*, from Borneo) those features of large flowers, emarginate labellum apex and large apical callus do occur either singly or in combination, without any geographical or ecological pattern.

Further variable features in *M. unifolia* include fragrance (present or absent), labellum callosities (smooth or rugulose), and lateral sepals recurved to rolled. Occasional specimens have forked inflorescences (*Wilson 679*, CHR) but this is probably due to virus infection. Moore (1970, p. 152) notes the presence of a strong sweet smell from the leaf and tuber of New Zealand plants.

Selected specimens (from c. 2,100 collections examined)

WESTERN AUSTRALIA: *C. Andrews s.n.*, 1903, York, bears label by A.S. George—"Very similar to type at BM of *Microtis media* R. Br. ..." (PERTH); *E.T. Bailey 966*, 13.xi.1924, Manjimup, bears label by A.S. George —"Similar to type at P of *Microtis unifolia* . . ." (PERTH); *R. Bates 2833*, 19.xii.1982, Denmark to Mt Barker (AD); *R. Bates 2892*, 24.xii.1982, Augusta (AD); *A.S. George 4188*, 16.x.1967, Queen Victoria Rocks (PERTH); *M.R. Pocock 73*, 17.xi.1969, Gnarlbine (AD); *R.S. Rogers 2203*, 26.x.1924, Coolgardie South (AD, MEL); *D.R. Voigt 34*, 17.xi.1976, NW of Cue (PERTH); *J.H. Willis s.n.*, 20.x.1962, Recherche Archipelago (MEL 99192).

QUEENSLAND: *E. Bowman s.n.*, 6.x.1966, Gympie (MEL 99117); *M.S. Clemens s.n.*, 14.x.1920, Moreton Bay (OA 42860); *M. Eaves s.n.*, 24.ix.1930, Mooloolah River (MEL 99235); *P. Hartman 174*, 16.ix.1970, Cardamine (MEL); *F. Mueller s.n.*, no date, Rockhampton (MEL 99120); *S.A. White s.n.*, 18.ix.1904, Enoggera (AD 97016516).

NEW SOUTH WALES: *J. Boorman s.n.*, 4.x.1926, Peak Hill (NSW 123815); *B. Briggs 6225*, 17.x.1968, Warrumbungles (NSW); *L. Cady 262*, 28.xii.1968, Kiama (AD); *G.M. Cunningham 3909*, 6.x.1968, Mt Wabalong (NSW); *R. Dickson 242*, 17.x.1980, Mootwingie Creek (AD); *M. Hammond s.n.*, 27.x.1956, Wagga Wagga (MEL 99269); *J. Robertson s.n.*, 26.ix.1862, Rosewater (NSW 123879).

VICTORIA: *A.C. Beauglehole 29637*, 19.xi.1968, Mt Arapiles (MEL); *A.C. Beauglehole 30017*, 11.xii.1968, Black Range, Grampians (MEL); *G. Lyell s.n.*, xii.1930, Gisborne (MEL 573852); *T.B. Muir 5370*, 27.x.1974, Whroo (MEL); *I.F. Norman s.n.*, 10.xii.1979, Rabbit Island (MEL 576459); *F.M. Reader s.n.*, 29.x.1892, Dimboola (MEL 99229); *J.H. Willis s.n.*, 22.xii.1951, swamps on Wilson's Promontory (MEL 99180); *J.H. Willis s.n.*, 20.x.1955, Anglesea, by highway (MEL 99250).

TASMANIA: *P. Barnett s.n.*, 17.xii.1970, King Island (MEL 584392); *R.C. Gunn 910*, 1837, McQuarie Harbour (OA 71208); *R.J. Milligan* (*Gunn 967*), 21.xi.1845, Long Point, Flinders Island (HO); *L. Rodway 36*, xi.1930, Blackmans Bay (HO); *J.E.S. Townrow s.n.*, 17.xi.1979, west side of Bruny Island (HO); *J.S. Whinray 243*, 29.xii.1965, Summit of Deal Island (HO).

SOUTH AUSTRALIA: *C.R. Alcock 3308*, 20.x.1976, near Streaky Bay (AD); *R. Bates 742*, 6.x.1976, Yardea, Gawler Ranges; *R. Bates 2101*, 3.xi.1981, Peter Creek (AD); *R. Bates 2381*, 27.xi.1981, Mt Compass (AD); *V. Jaegerman s.n.*, 1974, Aroona Valley, Flinders Ranges (AD 9734739); *B. Copley 3138*, 16.x.1972, Corny Point (AD); *D. Hunt 3382*, 24.xi.1962, Naracoorte (AD); *J.G.O. Tepper 20*, 16.x.1876, Nuriootpa (AD).

NEW ZEALAND: *J.K. Bartlett s.n.*, 17.xii.1970, Great Barrier Island (CHR 321397); *J. Clarke s.n.*, 24.xi.1964, Mangere Island, Chathams (CHR 189037); *T.F. Colenso s.n.*, x.1883, Curier Island (CHR 3447); *N. Lothian s.n.*, xii.1936, Waram Marble Deposits (AD 96232191); *R. Major 10*, 1947, Stewart Island (OA); *H.B. Matthews s.n.*, x.1924, Kaitaia (AD); *I.M. Ritchie s.n.*, 16.xi.1960, Codfish Island (AUK 150288); *H.D. Wilson 679*, 4.i.1948, Mt Cook area (CHR); *A.E. Wright 1924*, 17.xii.1978, near Auckland (AUK).

POLYNESIA: *A.C. Beauglehole 5503*, 18.xi.1962, Lord Howe Island (NSW); *J.P. Blanchon 969*, 15.ix.1964, Col. des Roussettes, New Caledonia (OA); *P.S. Green 1556*, 11.xi.1963, grassy rock ledges, south-east slopes of Malabar (OA); *R.D. Hoogland 6629*, 11.xii.1959, Transit Hill, Norfolk Island; *H.S. McKee 20633*, 28.xiii.1969, Canala, New Caledonia (NOUMEA).

INDONESIA: *M.J. Elbert s.n.*, no date, Lombok Island at 2,400 m. (AD 97263041); *R. Hoogland 7462*, 17.vii.1962, Borneo (AD); *J. van Steenis 10788*, 12.vii.1938, Jang Plateau West at 1900 m, Java (OA).

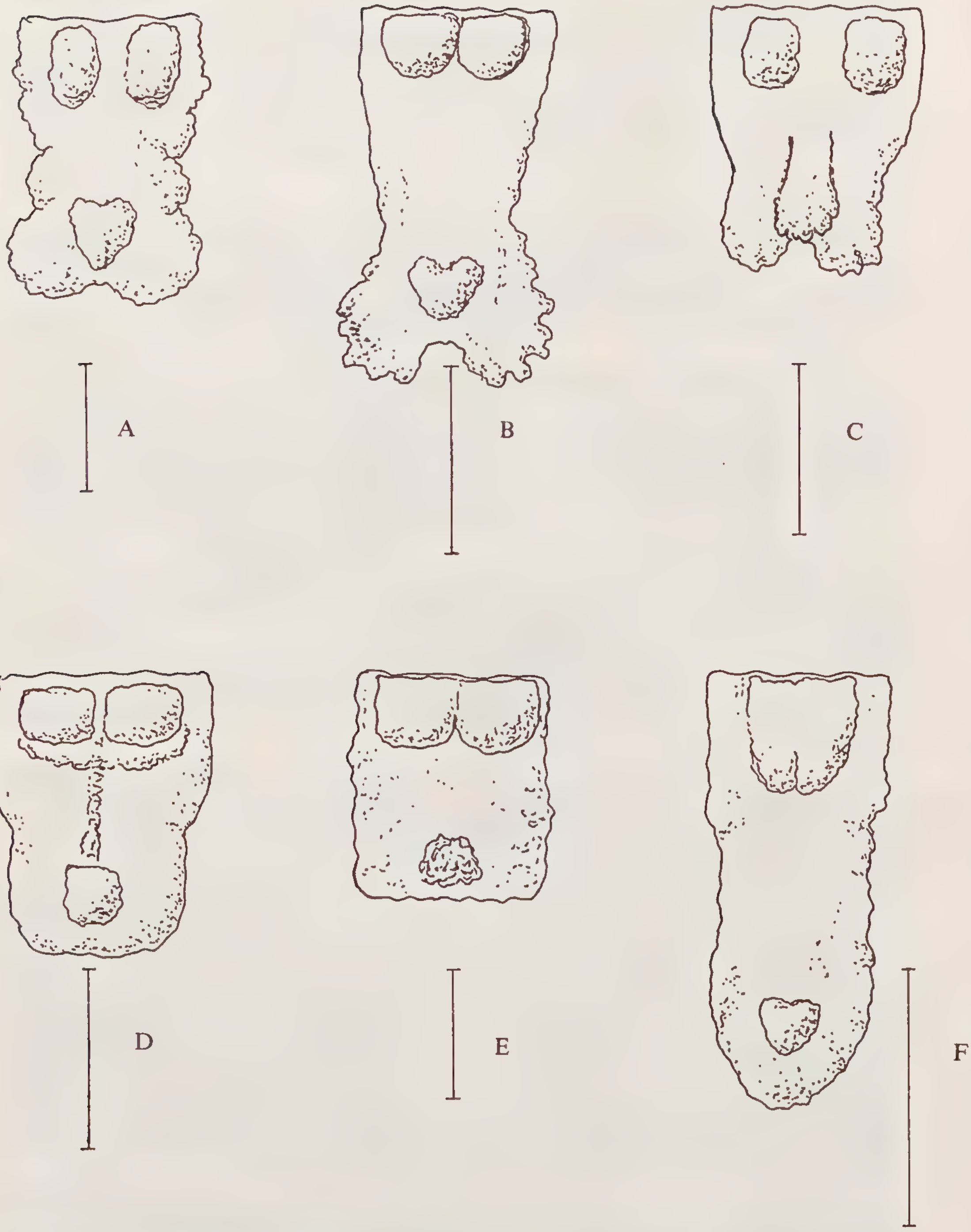


Fig. 5. Variation in the labellum morphology of *M. unifolia*. A, type and most common from (*E.T. Bailey 966*); B, coastal form (*R. Bates 2892*); C, small swamp form (*R. Bates 2101*); D, isotype of *M. aemula (R. Schlechter 14752)*; E, large swamp form (*R. Bates 2381*); F, unusual swamp form from Western Australia (*R. Bates 2940*). Scale = 1 mm. Illustration by G.R.M. Dashorst.

EAST ASIAN ISLANDS: *M. Hoff 1510*, 16.ii.1979, Mt Nakada at 600 m, Honshu (TO); *M. Jacobs 7414*, 16.iii.1968, Bontoc, Philippines (MANILA); *E. Merrill 4345*, 24.xi.1905, grassy slopes in pine forest, Bagnio, Luzon (OA); *F.P. Metcalf and T.C. Chang 938*, 1925, Awoy, Fuchien, Formosa (OA); *R. Tanaka 13546*, 13.vi.1933, Tomita-cho Kyushu (OA); *C. Wright 340*, 30.iv.1855, Loo Choo Islands (OA).

7. **M. oligantha** L.B. Moore, N. Zeal. J. Bot. 6: 473 t.i. (1968); Moore & Edgar, Fl. N. Zeal. 2: 154, t. 31 (1970); Cooper, Orch. N. Zeal. (1982); Johns & Molloy, Nat. Orch. N. Zeal., photos 83, 84 col. (1983).

Type: *J. Clarke s.n.*, Lake Roundabout, Ashburton Valley (South Island, New Zealand), 3.ii.1966 (CHR 150775, holo.!).

M. magnadenia non R. Rogers, sensu Hatch., Trans. Roy. Soc. N. Zeal. bot. 2: 187 (1963).

Plant slender, 2-15 (-25) cm high. *Tuberoid* globose 0.4-0.8 cm diam.; epidermis brown and not separating when mature. *Leaf* slender, 6-15 cm long, 0.3-0.6 mm diam.; apex erect or drooping; the fissure forming 1-5 cm from the leaf base. *Flowers* 1-10, green, not scented; the raceme rarely >4 cm long, moderately loose; the free scape 2-10 cm long, 1-1.5 mm diam. *Pedicel* 0.8 x 0.5 mm. *Floral bract* ovate, 1.0 x0.8 mm. *Dorsal sepal* ovate, 2.5 x 2.0 mm, only slightly concave; apex short, straight, obtuse. *Lateral sepals* ovate-lanceolate, 1.2 x 0.6 mm, depressed and spreading on either side of labellum, not recurved or revolute, almost flat; apex straight, sub-acute. *Petals* ovate-lanceolate, 1.0 x 0.6 mm, partly hidden below the dorsal sepal, sub-acute. *Labellum* oblong, 1.2-1.4 x 0.8-1.0 mm, sometimes constricted about the middle; apex truncate or emarginate, not apiculate; margins shallowly crenulate, or minutely papillose, sometimes thickened; apical callus variously developed, verrucose; basal calli squarish, 0.3 mm wide, separate or conjoined; nectary a short transverse furrow. *Column* c. 1.0 x 0.8 mm; the auricles square, 0.2 mm long. *Stigma* oval at anthesis but soon becoming irregular, 0.3 x 0.2 mm, prominent; rostellum indistinct. *Anther* hemispherical, 0.4 mm wide, retuse. *Pollinia* crumbly; caudicle absent; viscidium only visible at anthesis, minute. *Ovary* tumescent, much larger than flower, 4-8 mm long when mature, sub-cylindrical but flattened above and below. (Figs. 7C; 9C, D).

Distribution (Map 9)

Endemic in New Zealand where it is widespread in the South Island and also occurring in the highlands of the North Island and coastal Stewart Island.

Flowering

December to March, usually opening a little later than *M. unifolia* in the same area.

Ecology

Almost confined to short tussock grassland particularly around bogs, rarely associated with *M. unifolia*. In its natural tussock grassland *M. oligantha* is a dwarf plant usually less than 12 cm tall, but in well-shaded locations the plants become attenuated and may reach 25 cm. They do however retain the few flowered inflorescence and flower characters.

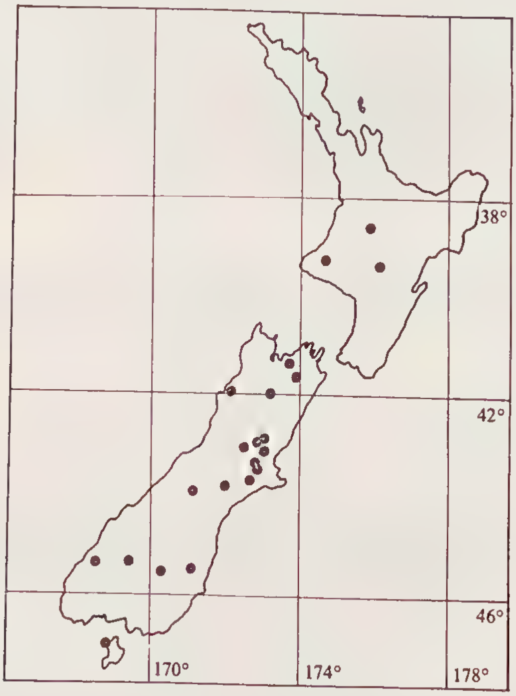
Affinities

Intermediate forms between *M. oligantha* and *M. unifolia* do occur in New Zealand (*Lothian s.n.* AD 97730402) but Molloy (1983, pers. comm. 1982) notes that where the two occur together around Christchurch they remain distinct and no hybrids have been detected. Some Tasmanian collections also contain plants closely approaching *M. oligantha* (*Simmonds 372* AD). Plants of *M. oligantha* and *M. unifolia* from New Zealand

flowered together under the same conditions at Adelaide Botanic Gardens in November 1982. The plants of *M. oligantha* were unusual in producing taller racemes than the *M. unifolia* but typical in having only 2-4 flowers. Attenuation of *M. oligantha* in cultivation was reported by Moore (1968). Preliminary work by Molloy (pers. comm. 1983) gives a chromosome count of 2n = 44 for *M. oligantha* and 2n = 88 for *M. unifolia* in New Zealand. Recent observation of cultivated plants by the author suggests that apomixy may occur in *M. oligantha.*

Although *M. oligantha* was not described until 1968, its distinctiveness was recognised about 1890 by T. Kirk who used the ms. name "*M. porrifolia* var. *alpina*" on his collections. Hatch (1963) also recognised them as different but he determined the plants as *M. magnadenia* R. Rogers. Most collections of *M. oligantha* seen were made after 1968, reflecting the interest shown by collectors after its publication as a species.

M. oligantha is a fairly constant taxon. Of more than 60 collections examined only six were difficult to place due to the fact that they contained a range of plants, some having up to twenty flowers indicating that they were either mixed collections or intergrades. Most collections are recognisable at a glance as the short slender plants generally have only 2-8 flowers. Moore (1970) distinguished *M. oligantha* as having "dorsal sepal obtuse, labellum almost quadrate, margins crenate rarely undulate and large basal calli squarish, not prominent"; although these features occur separately in populations of *M. unifolia* they do not occur all together.



Map 9. Distribution of *M. oligantha.*

Selected specimens (from 60 collections examined)

NEW ZEALAND: *A.M. Buchanan s.n.*, 4.iv.1969, Hoophorn spur, Mt Cook (CHR 245676); *D.J. Court s.n.*, 7.i.1968, Cavalli Island (AUK 150301); *A.P. Druce 210267*, 16.i.1966, Mt Egmont (CHR); *A.J. Healy s.n.*, 17.i.1968, Canterbury (CHR 182120); *P. Hynes s.n.*, 6.i.1940, Manora Hills, (bears the E.D. Hatch label 'M. magnadenia') (AUK 104839); *T. Kirk s.n.*, 1885, South Island, (bears label 'M. porrifolia Spreng. var. alpina') (AUK 30693); *R. Mason and N.T. Moor s.n.*, 12.xii.1958, Whangaramir (AD 9734732); *H.B. Matthews (Herb Cheeseman 3451)*, 17.i.1920, Rotorua (AUK); *B. Molloy s.n.*, sub *R. Bates 2122*, 4.i.1982, Cass (AD), and same cultivated Adelaide and flowers removed 2.xi.1982 (AD 98316721); *I. Robins s.n.*, 8.i.1968, Lake Tekapo (CHR 189066).

8. **Microtis rara** R. Br., Prod. 321 (1810); Sprengel, Syst. Veg. 3: 713 (1826); Lindley, Gen. sp. orch. pl. 396 (1840); W.M. Curtis, Stud. Fl. Tasm. 4a: 56 (1980).

Type: *R. Brown s.n.*, Port Jackson, New South Wales, 1804 (BM lecto., K!, ? AD iso!). The lectotype chosen here is the largest plant on the BM sheet. It is the specimen most closely matching Brown's original description.

M. unifolia (Forster f.) Reichb. f. var. *rara* (R. Br.) Reichb. f., Beitr. Syst. Pfl. 62 (1871). Based on *M. rara* R. Br.

M. media sensu Benth., Fl. Aust. 6: 348 (1873), non R. Br. (1810).
M. parviflora sensu Fitzg., Aust. Orch. 2 (1) t. col. (1884), non R. Br. (1810).

M. viridis F. Muell., Fragm. Phyt. Aust. 5: 97 (1866) pro. parte; Woolls, Contrib. Fl. Aust. 15 (1867).

M. brownii Reichb. f., Beitr. Syst. pfl. 24 (1871); George, Nuytsia 1 (2): 185 (1971).

Type: *R. Brown s.n.*, King George Sound, Western Australia, xii.1801, (K, lecto.!, E. iso.). George (1971) selected the lectotype. His 6.ix.1968 label on the type sheet reads: "This specimen matches an illustration by Reichb. f. at W. and also fits his description of *M. brownii* better than the other specimen". On this sheet are also two specimens labelled "*M. rara*, Swan River, Drummond 1839" in Lindley's hand.

Microtis truncata R. Rogers, Trans. & Proc. R. Soc. S. Aust. 44: 326 (1920) and l.c. 47: 340 (1923) for Latin diagnosis; Pelloe, W. Aust. Orch. 19 (1930); Erickson, Orch. West 47 (1951); Cady, Aust. Pl. 4: 163 (1967).

Type: *Miss I. Knox-Peden s.n.* sub *R.S. Rogers 2286*, Diamond Tree School near Jarnadup (Western Australia), xii.1918 (AD, lecto.!); *R. Pulleine s.n.* sub *R.S. Rogers 2285*, Greenbushes (Western Australia) 8.xii.1917 (AD, syn.!); *A. Syme-Johnson*, Albany, 4.xii.1919 (not located, syn.). The lectotype was chosen by George (1971). He did not see the Greenbushes specimen which was annotated as the type by Rogers but this was not published.

M. oblonga R. Rogers, Trans. & Proc. R. Soc. S. Aust. 47: 339 (1927); Pescott, Orch. Vict. 36 (1928); Ewart, Fl. Vict. 334 (1931); Black, Fl. S. Aust. edn 2 (1): 218 (1943); Rupp, Orch. N.S.W. 21 (1943); Nicholls, Vict. Nat. 66: 91, fig. P (1949); Willis, Handb. Pl. Vict. 1: 363 (1963); Firth, Nat. Orch. Tasm. 54 (1965); Cady, Aust. Pl. 4: 166 (1967); Nicholls, Orch. Aust. 24, t. 98 col. (1969); Gray, Vict. Nat. Orch. 2: 4 col. photo (1971); Cady & Rotherham, Aust. Nat. Orch. 22 (1972); Weber & Bates in J.P. Jessop ed., Black, Fl. S. Aust. edn 3 (1): 422, t. 401 (1978); Beadle et al., Fl. Sydney Reg. edn 3: 568 (1982).

Types: *A.B. Braine s.n.* sub. *R.S. Rogers 2205*, Ringwood, Vict., 19.ix.1920 (AD, lecto.!, AD, iso.!); *A.B. Braine s.n.* sub *R.S. Rogers 2206e*, Cravensville, Vict., 25.xii.1919 (AD, syn.!). (This sheet contains a mixed collection, some plants are *M. rara*, others *M. unifolia*); *E. Coleman s.n.* sub *R.S. Rogers 2206d*, Healesville, Vict., 1.i.1922 (AD, syn.!); *C.W. D'Alton s.n.* sub *R.S. Rogers 2206c*, Halls Gap, Grampians, Vict., ?.xii.1920 (AD, MEL, syn.!). The lectotype is a specimen from the Braine collection at AD which was annotated as type by Rogers.

M. magnadenia R. Rogers, Trans. & Proc. R. Soc. S. Aust. 54: 44 (1930); Rupp, Orch. N.S.W. 21 (1943); Cady, Aust. Pl. 4: 264 (1945), Beadle et al., Fl. Sydney Reg. edn 3: 568 (1982).

Type: *A.S. Dwyer s.n.* sub *R. Rogers*, Lake Wonboyne (New South Wales), "near the Prince's Highway", 28.xi.1929 (AD 96747077, holo.!).

Plant very slender, 15-45 (-60) cm high. *Tuberoid* globose, 0.5-1 cm diam.; epidermis drying brown and not separating. *Leaf* 20-50 (-65) cm long, 2-4 mm wide, tapering gradually to long, slender apex; fissure 1-2 cm long, forming 3-10 cm from leaf base. *Flowers* (5-) 10-30 (-50), fragrant, green, erect, spirally or alternately arranged in loose raceme, 5-25 cm long, free scape 5-20 cm long, c. 1 mm diam. *Pedicel* slender, 1-2 mm

long. *Floral bract* lanceolate, 3-4 x 1-2 mm, acuminate. *Dorsal sepal* ovate, (2-) 3-4 x 1.5-2 mm, shallowly concave below, margins paler coloured; apex with narrow, decurved, straight or recurved apiculus. *Lateral sepals* linear-oblong, 2-3 x 0.8 mm, spreading, recurved or revolute, sub-acute. *Petals* falcate-lanceolate, 2-2.5 x 0.8 mm, with pale margins, widely spreading below dorsal sepal, acute. *Labellum* ± oblong, 3-4 (-5) x 1-1.5 mm, usually constricted about middle, deflexed against ovary reaching more or less to base, margins crenulate, rugulose, often thickened (and drying darker coloured); apex truncate or emarginate; basal calli saddle-shaped, rounded or square, smooth, variable in size, 1-2 x 1-1.5 mm; nectary a 'W'-shaped transverse furrow at its base; apical callus rounded, oblong or irregular, 0.5-1.2 mm diam., tuberculate, rugulose or papillose, very variable. *Column* 1.2 x 0.8 mm, incurved with prominent, oblong to spathulate auricles, 0.3 x 0.2 mm. *Stigma* semi-lunate, 0.4 x 0.2 mm, concave; rostellum broadly triangular, 0.3 x 0.1 mm; apex asymetrically bifid. *Anther* hemispherical, 0.4 x 0.3 mm, cucullate, retuse, often with minute mucro. *Pollinia* coherent; caudicle c. 0.2 mm long; viscidium orbicular, c. 0.1 mm diam. *Ovary* ellipsoid, elongate, narrow at base, broader toward decurved apex, standing out from scape. (Figs 7D; 9E, F).

Distribution (Map 10)

Mainly coastal, occurring in the south-west of Western Australia and from near Rockhampton in Queensland, through New South Wales to Victoria, Tasmania and South Australia east of Adelaide.

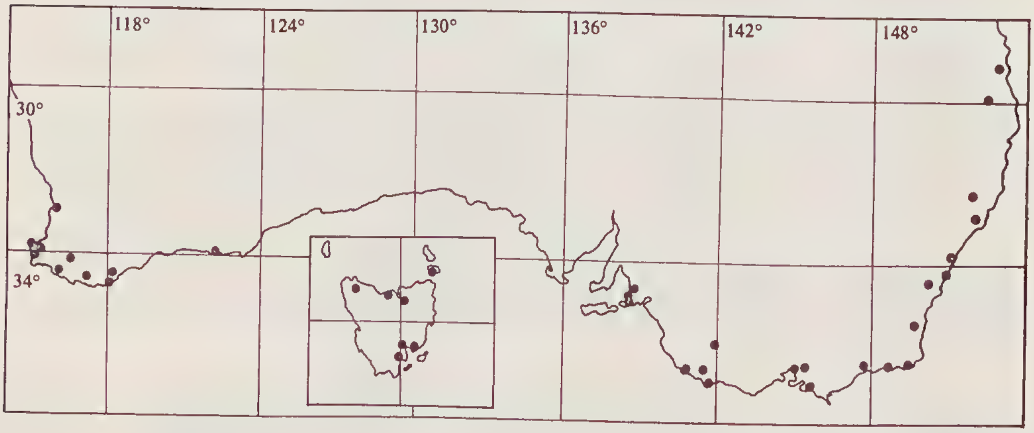
Flowering

October through to January, being later in the south or at higher altitudes.

Vernacular name: scented onion orchid, sweet onion orchid. (Willis 1962).

Ecology

Generally occurring in swamps or high rainfall areas, often in more densely shaded areas than other *Microtis* species. Growing singly or in small colonies. Flowering more freely after bushfires.



Map 10. Distribution of *M. rara.*

Affinities

M. rara is closely allied to both *M. alba* and *M. unifolia*. The three are indistinguishable on a basis of vegetative material alone. All have ovate dorsal sepals and generally revolute lateral sepals. *M. rara* differs from *M. unifolia* in being a more slender plant in bloom with flowers more distant on the spike; with narrower ovary, longer more slender pedicels, a broader, more shallowly concave dorsal sepal and a longer narrower labellum usually with thickened margins. The petals of *M. rara* are free while those of *M. unifolia* are generally partly hidden below the dorsal sepal. (Figs 9A, 9E). The differences between *M. rara* and *M. alba* are discussed under the latter species.

The identity of *M. brownii*, *M. truncata*, *M. oblonga* and *M. magnadenia* is as follows. When Brown was at King George Sound (Western Australia) in December 1801, among the four species of *Microtis* he gathered was a collection of *M. rara*, but he did not cite this collection in his "Prodromus" when describing *M. rara* from Port Jackson (New South Wales) material, nor did he apparently place any determination on it. This possibly influenced Reichenbach sixty years later to create a new name, *M. brownii* for the collection.

The types of *M. rara* and *M. brownii* differ only in size of flowers. George (1968) made a note to this effect on the *M. brownii* type sheet, but he did not cite the epithet among synonyms in his (1971) checklist. As both large and small flowered specimens have been collected throughout the range of *M. rara* and as there are no other distinguishing features, *M. brownii* is considered synonymous with *M. rara*. It is of interest that Reichenbach (1871) compared his *M. brownii* with *M. pulchella*, but did not mention *M. rara*.

When Rogers described *M. truncata* in 1920 from the south-west of Western Australia he had apparently not seen the type of *M. rara*. He had previously (1913) followed Bentham (1873) in treating *M. rara* as a synonym of *M. porrifolia* and was possibly unaware of the name *M. brownii*. George (1971) treated *M. truncata* as a synonym of *M. brownii* and I can find no reason to disagree with this as the types are very similar plants, and Rogers' description of *M. truncata*, although more elaborate than that of *M. brownii*, does not differ from it significantly.

Rogers (1923) when describing *M. oblonga* from Victoria, distinguished this species from his *M. truncata* on the basis of shape of labellum callosities, but as plants with either smooth or irregular callosities may be found even within a single population, this character is of little taxonomic value. The collections cited by Rogers as types of *M. oblonga* show a wide range of variation and although one sheet (*Rogers 2206e*) contains plants of *M. unifolia*, the rest, including the lectotype, are well within the range of *M. rara* and I follow Curtis (1981) in treating *M. oblonga* as a synonym of that species.

M. magnadenia was described from a single plant collected in New South Wales. Rogers (1930) distinguished the plant by its lateral sepals "not recurved", yet the lowest flowers have distinctly recurved lateral sepals! The only other difference indicated by Rogers lay in the "conspicuously raised" calli. These are clearly shown on a photograph accompanying the type and they are rather large. However, the calli of *M. rara* are very variable and I regard *M. magnadenia* to be no more than an unusually well developed specimen of *M. rara*.

Selected specimens (from c. 200 collections examined)

WESTERN AUSTRALIA: *R. Bates 2914*, 22.xii.1982, Pemberton (AD); *R. Coveny 4622*, 6.xi.1968, Busselton (NSW); *A.S. George 454*, 11.xii.1962, burnt swamps near Jandakot (NSW); *A.S. George and V. Mann 95*, 12.xi.1969, Nornalup Inlet in Jarrah forest (PERTH); *I. Knox-Peden s.n.*, 7.xii.1921, near Jarnadup (PERTH); *O.H. Sargent s.n.*, 7.xi.1918, York Hill Cutting (AD 97734720); *D. Voigt s.n.*, 16.xi.1979, Esperance area (PERTH).

QUEENSLAND: *F.M. Bailey s.n.*, x.1874, Maroochie (AD 97730568); *C. James 62*, 13.x.1938, Toowoomba (AD, NSW).

NEW SOUTH WALES: *L. Boormann s.n.*, 1902, Port Jackson (OA 25589); *L. Cady 462*, 21.ix.1958, Coffs Harbour (AD); *R. Filson 1421*, 1962, Barrington Tops (MEL); *R.C. Nash 934*, 12.xi.1966, Wedderton (AD); *W.H. Nicholls s.n.*, x.1937, Mt Sugarloaf (MEL 582286); *H.M.R. Rupp s.n.*, x.1923, Alum Mt., Bullahdelah (AD 97730570); *W. Schmidt s.n.*, 24.xi.1972, Maitland (NSW 102636).

VICTORIA: *A.C. Beauglehole 5125*, xii.1945, Portland swamps (MEL); *A.C. Beauglehole 30111*, 18.xii.1968, Golton Gorge, Grampians (MEL); *A.C. Beauglehole 32337*, 12.xii.1969, Mallacoota Inlet (MEL); *J. Brown s.n.*, 16.xii.1978, Springhurst (MEL 38374); *W. Hunter s.n.*, 6.xii.1937, Marlo (MEL 582248); *T.B. Muir 4815*, 25.i.1970, Mt Cobboras at 1500 m (MEL); *H.B. Williamson s.n.*, xii.1923, Emerald (MEL 99056).

TASMANIA: *T.E Burns s.n.*, Piper Heads Road (HO 37483); *W.M. Curtis s.n.*, 15.xii.1953, Piper Heads (HO 37517): *R. Gunn 673*, 2.i.1838, Black Lagoon (HO, MEL); *W.H. Nicholls s.n.*, i.1940, Mt Wellington (MEL 58225); *J.S. Whinray 363*, 20.xi.1969, Cape Barren Island (MEL, AD).

SOUTH AUSTRALIA: *R. Bates 576*, 17.xii.1979, 4 km west of Nelson (AD); *R. Bates 2532*, 4.xii.1981, Peter Creek Swamps, Kuitpo (AD); *E.H. Ising s.n.*, 25.xii.1934, Longwood (AD 97735056); *R.S. Rogers 2234*, Mt Compass (AD).

9. **Microtis alba** R. Br., Prod. 321 (1810); Sprengel, Syst. Veg. 3: 713 (1826); Lindley, Gen. sp. orch. pl. 396 (1840); F. Muell., Fragm. Phyt. Aust. 5: 97 (1866); Reichb. f., Beitr. Syst. Pfl. 62 (1871); Benth., Fl. Aust. 6: 348 (1873); Fitzg., Aust. Orch. unpub. t. 56; R. Rogers, Trans. & Proc. R. Soc. S. Aust. 44: 328 (1920); Pelloe, W. Aust. Orch. 19 (1930); Erickson, Orch. West, t. opp. p. 44 (1951); A.S. George, W. Aust. Nat. 8 (2): 40 (1961); Cady, Aust. Pl. 4: 165 (1967), Nicholls, Orch. Aust. 25. t. 99, col. (1969); Clyne, Aust. Ground Orch. photo opp. p. 68, col. (1970); A.S. George, Nuytsia 1 (2): 184 (1971); Pocock, Ground Orch. Aust. photo 84, col. (1972); Lothian, Rosa Fiveash Aust. Orch. t. 86 col. (1974) (A copy of Bauer's (1835) illust.?).

Type: *R. Brown s.n.*, King George Sound (Western Australia), xii.1801 (BM, lecto.!, K, iso.!). The lectotype was selected by A.S. George (1971) as holotype.

M. media sensu Hook., Curtis' Bot. mag., t. 3378 (1835), non R. Br. (1810).

Goadbyella gracilis R. Rogers, Trans. & Proc. Roy. Soc. S. Aust. 51: 294 (1927); Pelloe, W. Aust. Orch. 21 (1930); Erickson, Orch. West. 49, to. 16 (1951); Blackall & Grieve, W. Aust. Wildfl. 90 (1954).

Type: *P. Barwise s.n.* sub *R. Rogers 2015*, Pindalup (Western Australia) xi.1926 (AD, holo.!; PERTH, iso.!).

Plant usually slender, 15-60 (-90) cm high. *Tuberoid* globose, 0.5-1.2 cm diam., pale brown; epidermis not separating when mature. *Leaf* 15-50 (-80) cm long, 4-9 mm diam.; apex acuminate, erect or drooping; fissure 1-2 x 0.3 cm, forming 5-10 cm from leaf base. *Flowers* 10-50, very fragrant, white or greenish-white, thin-textured, inclined forward in loose to moderately dense raceme 5-20 cm long; free scape 6-18 cm long, c. 3 mm diam. *Pedicel* slender, 1-3 mm long. *Floral bract* ovate-lanceolate 3-4 x 1.5-2 mm acuminate. *Dorsal sepal* ovate-lanceolate, 4-5 x 2-2.5 mm, shallow, often constricted near base, tapering into recurved apiculum. *Lateral sepals* linear-oblong, 3-4 x 1-1.5 mm, rolled, acute. *Petals* linear-oblong, 3-4 x 1-1.2 mm, flat, falcate, spreading below dorsal sepal; apex incurved, sub-acute. *Labellum* more or less cuneate with bilobed apex, 4-6 (-8) mm long, pendulous; basal portion 2-3 x 0.9-1.1 mm, margins entire; expanding distally to c. 2 mm wide before branching into two divergent, oblong, lobes, each 1-3 x 1-2 mm; their margins crenulate, papillose, granular, drying darker than rest of flower; basal callus oblong, 0.5-1 x 0.5-0.8 mm, much raised, smooth, longitudinally channelled at first, then tapering into shallow, tuberculate, hemispherical apron; apical callus irregular, c. 1.5 x 1 mm, rugulose or papillose, situated just below sinus of two lobes, sometimes extending onto them. *Column* c. 1.2 x 0.5 mm, with prominent, falcate-lanceolate auricles, c. 0.3 x 0.1 mm, spreading on either side of anther. *Stigma* ovate to semi-lunate, c. 0.2 mm diam., concave; rostellum triangular, erect, c. 0.2 x 0.1 mm, bifid. *Anther* c. 0.2 x 0.1 mm,

cucullate, retuse with minute, membranous, decurved mucro. *Pollinia* coherent; caudicle <0.1 mm long, viscidium orbicular. *Ovary* elongate, 3-5 x 1-2 mm, decurved apically. *Seeds* pale. (Figs 7E; 9G, H).

Distribution (Map 3)

Endemic to south-west Western Australia and widespread in an arc from near Esperance in the east to north of Perth.

Flowering: October to January.

Vernacular name: white mignonette orchid (Nicholls 1969).

Ecology

Occurring in heathland or forest and flowering more freely after fire. The flowers attract a wide variety of insects, and small hymenopterans were observed transferring pollinia. Hybridism with *M. rara* and *M. unifolia* is suspected (Brown 1982, Heberle pers. comm. 1982) and this would help to explain the wide range of intermediate forms.

Affinities

M. alba is most closely allied to *M. rara* and the species are often sympatric in the west (*M. rara* also occurs in eastern Australia). The author collected both growing and flowering together near Pemberton (*R. Bates 2909*, *2914*) in December 1982. No intermediates were seen. The two species are not distinguishable from vegetative material alone. Although *M. alba* has larger flowers, both have similar ovate dorsal sepals, revolute lateral sepals and spreading petals. They differ markedly in labellum structure (Figs 9E, 9G). The labellum of *M. alba* is cuneate with two apical divaricate lobes, while that of *M. rara* is oblong and not produced into lobes. Minor differences include the flower colour, white in *M. alba* and green in *M. rara*, and shape of auricles.

Rogers (1927) described the genus *Goadbyella* with one species *G. gracilis*. The single collection was made from Pindalup, an area where *M. alba* is common. Rogers on his notes accompanying the type sheet wrote, "Sent to me by Mr. P. Barwise with a parcel of *M. alba*". No similar plants have been found. Rogers stated that the genus differed from *Microtis* ". . . in its reversed flowers, slender and somewhat elongated column, its narrow non-cucullate dorsal sepal and its wide truncate lateral sepals". The type is clearly teratological, and flowers are irregular and variable, without ovaries, some with duplicate labella and petals, the columns incomplete, and I agree with the conclusion of George (1961, 1971) that *G. gracilis* is an aberrant specimen of *M. alba*.

Selected specimens (from c. 150 collections examined)

WESTERN AUSTRALIA: *T. Alpin 264*, 6.xi.1958, Red Hill (PERTH); *R. Bates 2902*, 23.xii.1982, Pemberton (AD, PERTH); *J. Forrest s.n.*, xi.1881, Toolbrunup Peak (MEL 9899); *A.S. George 407*, 14.xi.1959, open burnt sandplain 32 km east of Cranbrook (PERTH); *A.S. George 9730*, 12.x.1909, Broke Inlet (PERTH); *B.T. Goadby s.n.*, xi.1900, King George Sound (AD 97730448); *R. Heberle s.n.*, 7.xii.1981, Albany (AD 98222345); *I. Knox-Peden s.n.*, 4.xii.1921, Yarowee (PERTH); *K. Newbey 1710*, 12.xi.1964, Frenchman Bay (PERTH); *E. Pritzel 922*, xi.1901, Darling Range (AD); *M.R. Pocock 114*, 14.x.1968, Emu Point near Albany (AD); *R.D. Royce 2511*, 5.xi.1947, Busselton (PERTH); *J. Steedman s.n.*, xi.1931, Frankland River (PERTH); *D. Voigt s.n.*, 6.xi.1979, Cape le Grande (PERTH); *S.E. White s.n.*, 28.x.1920, Mundaring Weir (AD 966120403).

Doubtful and insufficiently known names

"*Micropera banksii* Hook.", "*Micropera media* R. Br.", "*Micropera parviflora* R. Br." and "*Microtis pallida* Lindley", Heynold, Nom. bot. hort. 1 (2): 523 (1840) in obs. are probable errors in transcription. They are given in 'Index Kewensis' as *nomina dubia*

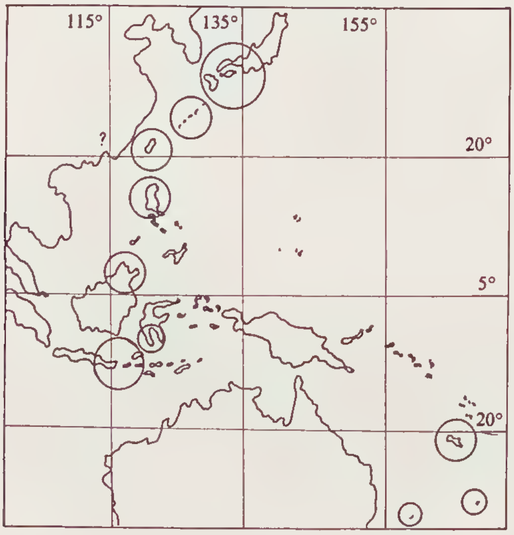
except for *Micropera parviflora* which is given (probably incorrectly) as a synonym of *Sarcochilus parviflorus* Lindley. They would seem to have resulted from accidental transposition of specific epithets from two totally unrelated genera and are probably based on *Microtis banksii* Hook., *Microtis media* R. Br., *Microtis parviflora* R. Br. and *Micropera pallida* Lindley.

"*Microtis parvifolia* is given by Steudel, Nom. bot. 1: 531 (1821) as a synonym of *Serapias parvifolia* Pers., but neither name appears in 'Index Kewensis'.

M. formosana Schltr., Bot. Jahrb. Syst. 29: 37 (1906) nom. nud.; Schltr. ibid 45: 382 (1911). Schlechter cites no collection and I have not seen any annotation to show on which specimen he based the name. He used the name for plants from 'Formosa' (Taiwan). All plants from Taiwan examined by me have been referred to *M. unifolia* but illustrations of Taiwanese material in several publications (Hayata, Icon. Pl. Formosa 4: 23 (1914) and Lin, Fl. Taiwan 1062 [1978]) appear to be of *M. parviflora.*

Acknowledgements

I am grateful to the authorities at the following herbaria for the loan of material: AK, BM, CHR, GOET, HO, K, MANILA, MEL, NOUMEA, NSW, OA, P, PERTH, TO, WELT and to the staff at AD particularly to Dr H. Toelken who provided the Latin diagnosis for *M. globula.* I am also indebted to Dr B. Molloy of Christchurch and Mr R. Heberle of Albany for providing plants; to Mr M. Clements for help with the manuscript; to Ms A. Prescott who assisted with the illustrations, my mother Mrs M. Bates for typing the manuscript and Dr J.H. Warcup, who provided information on the mycorrhiza.



Map 11. Distribution of *Microtis* outside Australia and New Zealand.

Fig. 6. Silhouettes of *Microtis* species as taken from herbarium specimens. A, *M. atrata* (*R.S. Rogers 2178*); B, *M. orbicularis* (*R. Bates 2094*); C, *M. globula* (*R. Bates 2923*); D, *M. pulchella* (*R. Bates 2916*).

Fig. 7. Silhouettes of *Microtis* species as taken from herbarium specimens. A, *M. parviflora* (*H. Goldsack 477*); B, *M. unifolia* (*R. Bates 742*); C, *M. oligantha* (*N. Weir 377*); D, *M. rara* (*R. Bates 2532*); E, *M. alba* (*R. Bates 2902*).

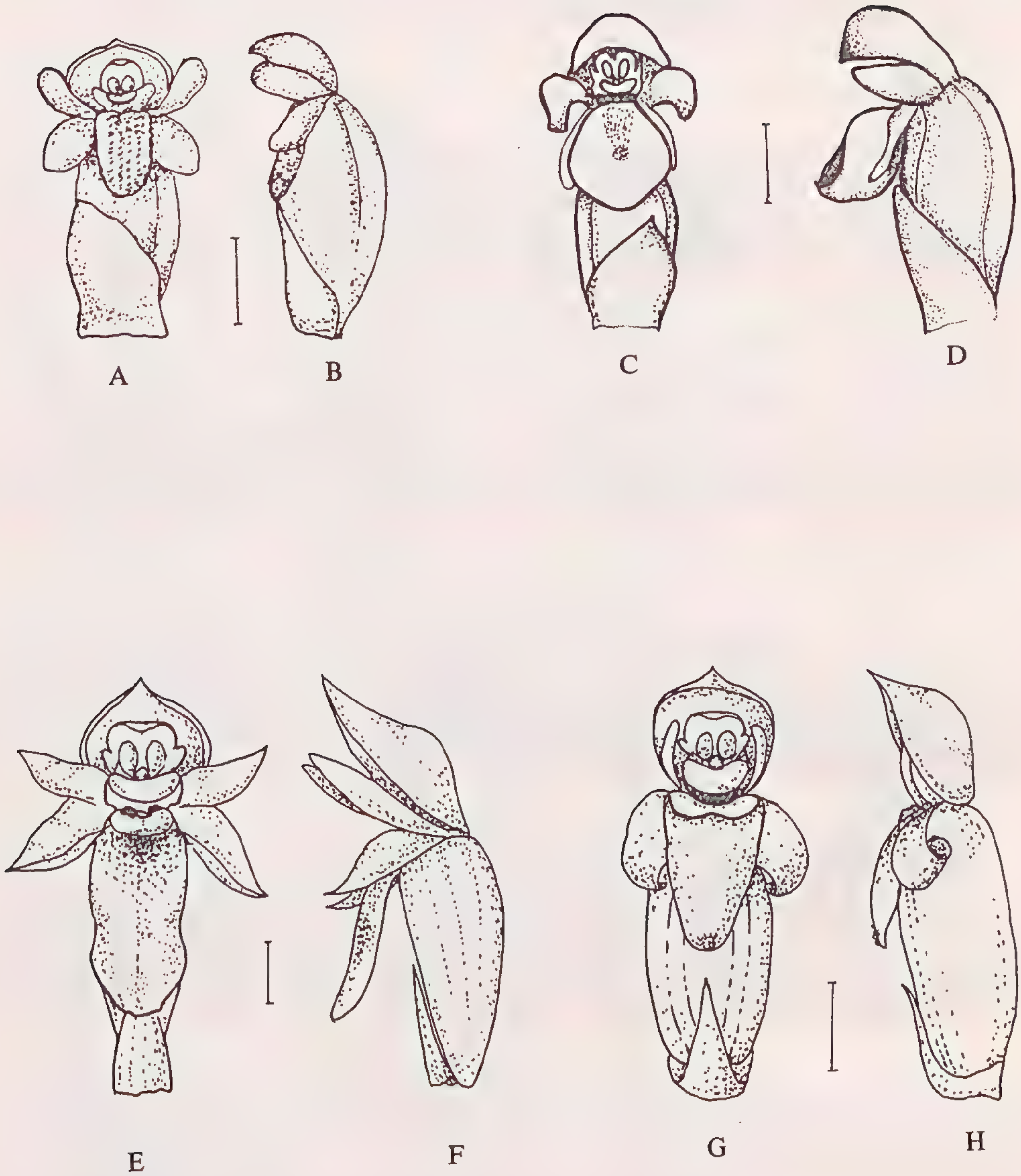


Fig. 8. Flowers in front and side view. A & B, *M. atrata* (*R. Bates 2093*, Kuitpo, S. Australia); C & D, *M. orbicularis*, (*R. Bates 2094*, Kuitpo, S. Australia); E & F, *M. pulchella* (*R. Heberle* sub R. Bates 2128, Albany, W. Australia); G & H, *M. parviflora* (*R. Bates 2127*, Kuitpo, S. Australia). Scale = 1 mm. Illustrations A, B, E-H by G.R.M. Dashorst; C & D by A. Prescott.

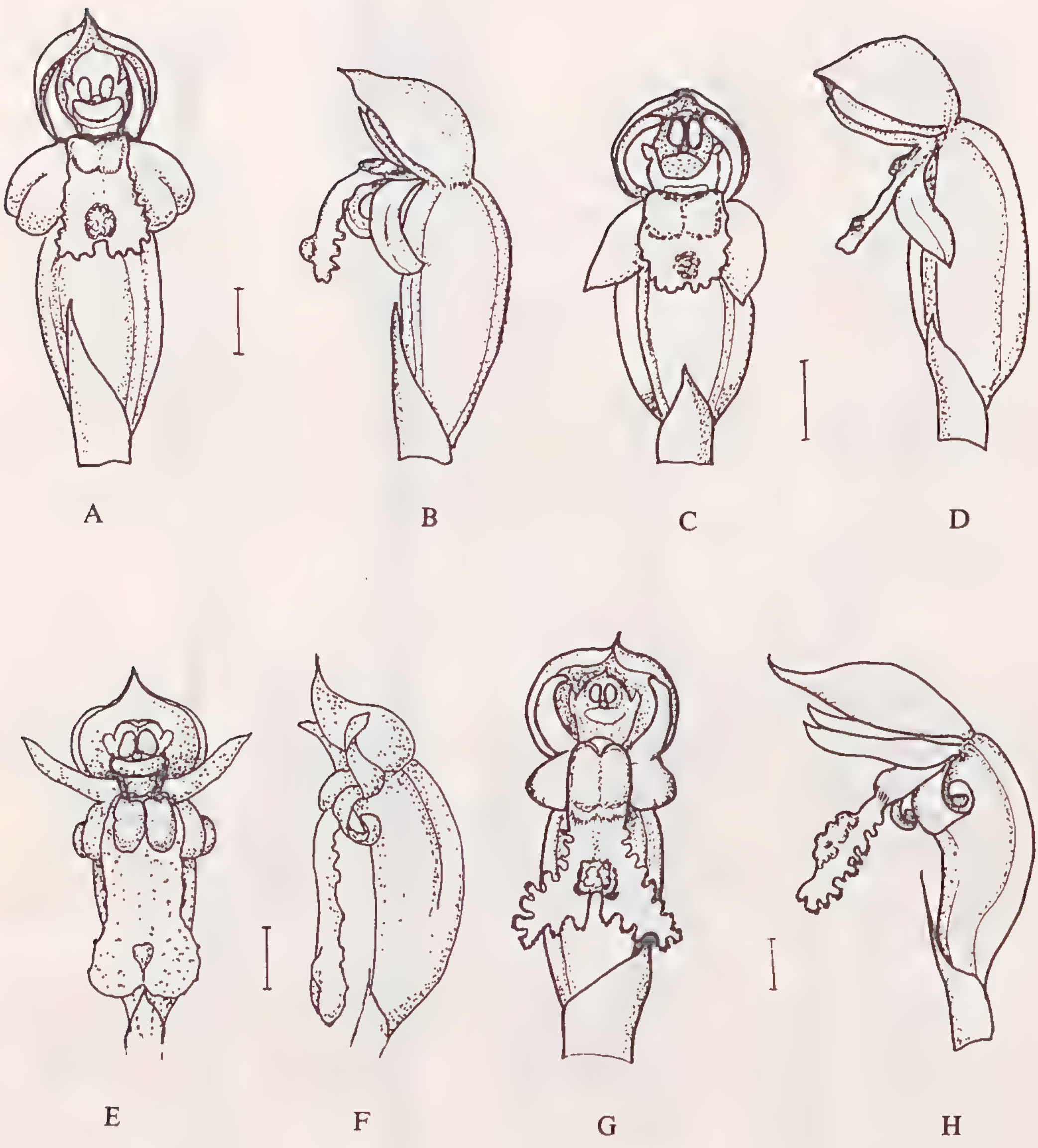


Fig. 9. Flowers in front and side view. A & B, *M. unifolia* (*R. Bates 2845*, Kuitpo, S. Australia); C & D, *M. oligantha* (*B. Molloy s.n.*, Arthurs Pass, N. Zealand); E & F, *M. rara* (*R. Bates 2368*, Mylor, S. Australia); G & H, *M. alba* (*R. Heberle s.n.*, Albany, W. Australia). Scale = 1 mm. Illustrations A & B by G.R.M. Dashorst, C-H by A. Prescott.

References

Ames, O. (1905-1922). "Orchidaceae, illustrations and studies of the family . . .". Fasc. 1-7. (Riverside Press: Cambridge).

Backer, C.A. & Bakhuizen, R.C. (1968). "Flora of Java". Vol. 3. (Wolters-Noordhoff: Groningen).

Bates, R. (1978). "South Australia's rarest native orchids number 8." *J. Nat. Orch. Soc. South Australia* 2 (1): 3-4.

Bates, R. (1981a). "Observation of pollen vectors on a hybrid swarm of *Microtis* R. Br.", *Orchadian* 7: 14-15.

Bates, R. (1981b). "Cultivation of *Microtis*". *J. Nat. Orch. Soc. South Australia* 5 (6): 54-55.

Bates, R. (1983a). "Pollination concepts in *Thelymitra* R. Br.". *J. Nat. Orch. Soc. South Australia* 7: 8-9.

Bates, R. (1983b). "Apomixy in two South Australian orchids (*Microtis orbicularis & Paracaleana minor.*)". *J. Nat. Orch. Soc. South Australia* 7: 35-36.

Beauglehole, A.C. (1978). "Alterations & additions to the vascular flora of Victoria—part 1.". *Victorian Naturalist* 95: 134.

Bentham, G. (1873). "Flora Australiensis". Vol. 6. (Reeve: London).

Bentham, G. & Hooker, J.D. (1883). "Genera plantarum", Vol. 3 (2). (Reeve: London).

Brown, A. (1982). "Rare new species, varieties & hybrids of terrestrial orchids in the south-west of Western Australia". *Bull. W.A. Nat. Orch. Study & Conservation Group.* (January, unpag.).

Brown, R. (1810). "Prodromus florae Novae Hollandiae . . . ". (Taylor: London).

Brunnich, J.C. (1914). "Alkaloids in some Queensland orchids". *Qld Agric. Chem. Rept.* 8: 67.

Cady, L. (1967). "The genus *Microtis* in Australia". *Austral. Pl.* 4: 163-7.

Cheeseman, T.F. (1925). "Manual of the New Zealand flora" edn 2. (Govt Printer: Wellington).

Clements, M.A. (1982). "Preliminary checklist of Australian Orchidaceae". (National Bot. Gardens: Canberra).

Colenso, W. (1885). "A description of some newly discovered and rare indigenous plants . . . part 1". *Trans. & Proc. New Zealand, Inst.* 17: 235-260.

Colenso, W. (1886). "A description of some newly discovered and rare indigenous plants . . . part 2". *Trans. & Proc. New Zealand Inst.* 18: 259-273.

Curtis, W.M. (1953). "A census of the orchids of Tasmania". *Proc. Roy. Soc. Tasmania* 87: 138.

Curtis, W.M. (1980). "The student's flora of Tasmania part 4A". (Govt Printer: Hobart).

Diels, L. (1903). "Two new species of Orchidaceae from Western Australia". *J. Proc. Muell. Bot. Soc. Western Australia* 1 (11): 79.

Dockrill, A. (1969). "Australian indigenous orchids". Vol. 1. (Society for Growing Australian Plants: Sydney).

Dressler, R.L. (1981). "The orchids: natural history & classification". (Harvard Univ. Press: Cambridge).

Erickson, R. (1951). "Orchids of the west". (Paterson-Brokensha: Perth).

Fitzgerald, R.D. (1875-94). "Australian orchids". (Govt Printer: Sydney).

Forster, G. (1786). "Florulae insularum australium prodromus". (Dietrich: Goettingen).

French, C. (1886). "Orchideae of Victoria", part 9. *Victorian Naturalist* 2: 130-132.

Garay, L.A. & Sweet, R. (1974). "Orchids of the southern Ryukyu Islands". (Bot. Museum: Massachusetts).

Garnett, J.R. (1980). "On lawns, wildflowers, weeds and orchids". *Victorian Naturalist* 97: 23-25.

George, A.S. (1961). "Notes on Western Australian Orchidaceae II". *Western Australian Naturalist* 97: 23-25.

George, A.S. (1971). "A checklist of the Orchidaceae of Western Australia". *Nuytsia* 1 (2): 166-196.

Green, J.W. (1964). "Discontinuous plant species in southern Australia". *Proc. Roy. Soc. Western Australia* 47: 25-27.

Green, J.W. (1981). "Census of the vascular plants of Western Australia". (Govt Printer: Perth).

Hallé, N. (1977). "Flore de la Nouvelle Caledonie". Vol. 8. (Museum Natural d'histoire: Paris).

Hatch, E.D. (1963). "Notes on New Zealand orchids II". *Trans. Roy. Soc. New Zealand, Bot.* 2: 185-188.

Heynhold, G. (1840). "Nomenclator botanicus hortensis . . .". edn 1 (2). (Arnold: Dresden & Leipzig).

Heynhold, G. (1846). "Nomenclator botanicus hortensis . . .". edn 2 (2). (Arnold: Dresden & Leipzig).

Hooker, J.D. (1860). "Flora Tasmaniae". Vol. III. (Reeve: London).

Hooker, W.J. (1835). Curtis' Botanical Magazine 62 sub. t. 3377, t. 3378. (London).

Jacobs, S.W.L. & Pickard, J. (1981). "Plants of New South Wales". (Govt Printer: Sydney).

Jones, D.L. (1975). "The pollination of *Microtis parviflora* R. Br.". *Ann. Bot.* (new series) 39: 585-589.

Jones, D.L. (1976). "Miscellaneous notes on Australian Orchidaceae". *Orchadian* 5: 83-87.

Kraenzlin, J. (1885). "Orchidaceae Yunnan Sinensis". *Bot. Jahrb. Syst.* 6: 55.

Lavarack, P. (1971). "Affinities of the Australian Neottioidea". *Taxon*: 289-296.

Lavarack, P. (1976). "Some name changes affecting Australian orchids". *Orchadian* 5: 65 (1976).

Lawler, L.J. (1981). "Ethnobotany of Australian orchids". Proc. Orch. Symposium (13th International Bot. Congress, Sydney).

Leigh, J., Briggs, J. & Hartley, W. (1981). "Rare or threatened Australian plants". (Govt Printer: Canberra).

Lindley, J. (1826). "Orchidearum sceletos". (Taylor: London).

Lindley, J. (1840a). "A sketch of the vegetation of the Swan River Colony". Edwards Bot. Reg., Appendix to the first 23 volumes. (Ridgeways: London).

Lindley, J. (1840b). "The genera and species of Orchidaceous plants . . .". (Ridgeways: London).

Mansfeld (1937). "Über das System der Orchidaceae-Monandrae". *Notizbl. Bot. Gart. Berlin-Dahlem* 13: 666-676.

McAlpine, D. (1895). "Systematic arrangement of Australian fungi . . .". (Govt Printer: Melbourne).

Moore, L.B. (1968). "Taxonomic notes on New Zealand Monocots". *New Zealand J. Bot.* 6: 473.
Moore, L.B. & Edgar, E. (1970). "Flora New Zealand". Vol. 2. (Govt Printer: Wellington).
Mueller, F. (1855). "Botany of Victoria". *Hooker's J. Bot. Kew Gard. Misc.* 7: 241.
Mueller, F. (1859). "Fragmenta phytographiae Australiae". Vol. 1. (Govt Printer: Melbourne).
Mueller, F. (1866). "Fragmenta phytographiae Australiae". Vol. 5. (Govt Printer: Melbourne).
Mueller, F. (1882). "Systematic census of Australian plants". (McCarron, Bird: Melbourne).
Nash, R.C. (1967). "Methods used with South Australian *Microtis*". *Austral. Pl.* 4: 170.
Nicholls, W.H. (1949). "The genus *Microtis* in Victoria". *Victorian Naturalist* 66: 90-97.
Nicholls, W.H. edited D.L. Jones & T.B. Muir (1969). "Orchids of Australia". (Nelson: Melbourne).
Oliver, R.R. (1976). "Less-known orchids of Western Australia". *Nat. Walkabout Western Australia* 12: 64-72.
Palmer, P. (1967). "Microtis in Tasmania". *Austral. Pl.* 4: 167.
Pijl, L. van der & Dodson, C.H. (1966). "Orchid flowers, their pollination & evolution". (Uni. Miami Press: Florida).
Reichenbach, H.G. (1849). In W.G. Walper's "Annales botanices systematicae". 1 (4). (Abel: Leipzig).
Reichenbach, H.G. (1857). "Orchidaceae Javanicae". *Bonplandia* 5: 36.
Reichenbach, H.G. (1871). "Beiträge zur Systematischen Pflanzenkunde". (Meissner: Hamburg).
Rodway, L. (1903). "The Tasmanian flora". (Govt Printer: Hobart).
Rogers, R.S. (1907). "A new *Microtis*". *Trans. & Proc. Roy. Soc. South Australia* 31: 63.
Rogers, R.S. (1920). "Contributions to the orchids of Australia". *Trans. & Proc. Roy. Soc. South Australia* 44: 376.
Rogers, R.S. (1923). The distribution of Australian orchids". *Trans. & Proc. Roy. Soc. South Australia* 47: 322-334.
Rogers, R.S. (1927). "Contributions to Australian orchidology". *Trans. & Proc. Roy. Soc. South Australia* 51: 294.
Rogers, R.S. (1929). "Contributions to the orchidology of Papua & Australia". *Trans. & Proc. Roy. Soc. South Australia* 54: 44-46.
Schlechter, R. (1907). "Beitrage zur Kenntnis der Orchidaceen von Neu-Kaledonien". *Bot. Jahrb. Syst.* 39: 37.
Schlechter, R. (1911). "Die Polychondrae (Neottiinae Pfitz.) und ihre systematische Einteilung". *Bot. Jahrb. Syst.* 45: 382.
Schlechter, R. (1926). "Das System der Orchidaceen . . .". *Notizbl. Bot. Gart. Berlin-Dahlem* 88 (9): 563-591.
Schlechtendahl, D. (1847). "Bestimmung und Beschreibung der von Dr. Behr in Süd-Australien gesammelten Pflanzen". *Linnaea* 30: 560-571.
Sprengel, K. (1826). "Caroli Linnaei . . . systema vegetabilium". edn 16 (3): 713 (Göttingen).
Steudel, E.G. (1824). "Nomenclator botanicus . . .". edn 1 (1). (Tübingen, Stuttgart).
Steudel, E.G. (1841). "Nomenclator botanicus . . .". edn 2 (1). (Tübingen, Stuttgart).
Stoutamire, W. (1964). "Terrestrial orchid seedlings". *Austral. Pl.* 2: 119-122.
Sullivan, D. (1882). "Native plants of the Grampians". *Wings Southern Science Record* 3 (9): 214-224.
Swartz, O. (1800). "Character generalis orchidearum". *Kongl. Vetensk. Acad. Handl.* ser. 1, 21: 233.
Tanaka, R. (1965). "Chromosome numbers of some species of Orchidaceae from Japan". *J. Jap. Bot.* 40 (3): 65-77.
Thompson, G.M. (1879). "On the methods of fertilisation of some New Zealand orchids". *Trans. & Proc. New Zealand Inst.* 11: 418-424.
Tucker, E. (1904). "Onion orchids". *Victorian Naturalist* 81: 47.
Vermuelen, P. (1966). "The system of the Orchidales". *Acta Bot. Neerl.* 15: 224-253.
Warcup, J.H. (1981). "The mycorrhizal relationships of Australian orchids". *New Phytol.* 87: 371-381.
Willis, J.H. (1953). "Orchids at Creswick". *Victorian Naturalist* 70: 8.
Willis, J.H. (1962). "A handbook to plants in Victoria" Vol. 1. (University Press: Melbourne).
Withner, C.L. (editor) (1959). "The orchids, a scientific survey". (Ronald Press: New York).

Index to scientific names

Names

New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked (*) refer to figures and maps.

J. Adelaide Bot. Gard. 7(1): 91-116 (1984)

A TAXONOMIC REVISION OF THE GENUS *GMELINA* L. (VERBENACEAE)* IN AUSTRALIA

Ahmad Abid Munir

State Herbarium, Botanic Gardens, North Terrace,
Adelaide, South Australia, 5000.

Abstract

A taxonomic revision of *Gmelina* in Australia is presented. The following five species are recognised: *G. elliptica, G. leichhardtii, G. fasciculiflora, G. schlechteri* and *G. dalrympleana. G. schlechteri* and *G. elliptica* are recorded from Australia for the first time. *G. leichhardtii, G. fasciculiflora, G. schlechteri* and *G. dalrympleana* are typified. *G. vitiensis* and *Vitex vitiensis* are regarded as new synonyms of *G. dalrympleana*. A range of specimens have been examined from Malesia.

The affinities and distribution are considered for the genus and each species. A key to the species is provided and a detailed description of each species is supplemented by a habit sketch of a flowering branch and analytical drawings of the flower.

Taxonomic History of the Genus

The genus *Gmelina* was described by Linnaeus (1753) with one species, *G. asiatica*, the type of which came from India. It was placed in "Didynamia Angiospermia" without reference to any family, where it was retained by Burman (1768), Murray (1774), Reichard (1778), Loureiro (1793), Schreber (1791), Gmelin (1791), Persoon (1797, 1807), Roxburgh (1832), Willdenow (1800), Poiret (1823), Sprengel (1825), Blanco (1837), Dietrich (1843) and a few others. Adanson (1763) placed it in "Verbeneae", Scopoli (1777) in "Personatar", Gaertner (1788) in "Centuria Quarta", Jussieu (1789) in "Vitices", Necker (1790) in his "Chasmatophytorum", Ventenat (1799) in "Pyrenaceae", and Reichenbach (1828) under the tribe "Verbeneae" in the Labiatae. In 1806, de Jussieu referred it to the family Verbenaceae where it has been retained by most, if not all, botanists.

Dumortier (1829) divided the Verbenaceae into two tribes: Verbeneae and Viticeae, with *Gmelina* in the tribe Viticeae. This tribe was accepted for the genus by Bartling (1830), Spach (1840), Schauer (1847), Walpers (1852), Miquel (1858), Bentham (1870), Bentham & Hooker (1876), Bailey (1883, 1901, 1913), Clarke (1885), Durand (1888), King & Gamble (1909), Fletcher (1938) and Lemée (1943). The above-named tribes were called "sections" by Bartling (1830) and Spach (1840). In 1836, Endlicher divided the family Verbenaceae into three tribes: Lippieae, Lantaneae and Aegiphileae, with *Gmelina* in the tribe Lantaneae. This tribe was accepted for the genus by Meisner (1840), Endlicher (1841), Brongniart (1843), Dietrich (1843) and Walpers (1845).

In 1895, Briquet reclassified the Verbenaceae and upgraded the tribe Viticeae to a subfamily Viticoideae. The latter consisted of four tribes: Callicarpeae, Tectoneae, Viticeae and Clerodendreae, with *Gmelina* in the tribe Viticeae. This classification was accepted by Dalla Torre & Harms (1904), H.J. Lam (1919), Junell (1934) and Moldenke (1959, 1971). In the same treatment, Briquet (1895) subdivided the genus into two sections: Microstromatae and Bracteosae, each characterised chiefly by the size, colour and venation of their floral bracts. He referred all Australian species to the section Microstromatae. These infrageneric sections were adopted by Dalla Torre & Harms (1904) and Moldenke (1959, 1971). The majority of botanists, however, have not divided the genus into sections, but have retained it in the Verbenaceae without reference to any subfamily or a tribe.

*The present treatment of the genus *Gmelina* is the third in the series of taxonomic revision in the family Verbenaceae in Australia (See Munir, 1982, 1984).

Australian History of the Genus

The first Australian collection of *Gmelina* was made by Banks & Solander during 1770 from northern Queensland. It was described by Robert Brown (1810) as *Vitex macrophylla*. In 1847, Schauer recorded this species under "species non satis notae" without elaborating on its short original description or citing any plant collection from Australia. It was later recorded by Seemann (1865) and F. Mueller (1868). In 1862, Mueller described one of Dr Ludwig Leichhardt's collections from New South Wales as *Vitex Leichhardtii*. About two years later, F. Mueller (1864) described J. Dallachy's collection(s) from Rockingham Bay, Queensland, as *Vitex dalrympleana*. Bentham (1870) published a detailed account of the Australian Verbenaceae, and listed three *Gmelina* species: *G. macrophylla* (R. Br.) Benth., *G. leichhardtii* (F. Muell.) Benth. and *G. fasciculiflora* Benth. Of these, *G. fasciculiflora* Benth. was described as a new species. Subsequently, the occurrence of these species in Australia was recorded by F. Mueller (1882, 1889), Bailey (1883, 1901, 1913), and Francis (1951). Of these, *G. macrophylla* (R. Br.) Benth. was later found by H.J. Lam (1919) to be an illegitimate name, and was, therefore, replaced by *G. dalrympleana* (F. Muell.) H.J. Lam. All these species were later recorded for Australia by Moldenke (1959, 1971, 1980).

In the present publication, Briquet's (1895) classification of the Verbenaceae is accepted for the genus, and all Australian species are retained in the subgeneric section Microstromatae. *G. dalrympleana* var. *schlechteri* (H.J. Lam) Moldenke is reinstated as a species, *G. schlechteri* H.J. Lam. *Vitex vitiensis* Seemann is regarded as a new synonym of *G. dalrympleana* (F. Muell.) H.J. Lam. In all, five species are recognised from Australia of which *G. schlechteri* and *G. elliptica* are newly recorded.

GMELINA L.

Gmelina L. [Gen. Pl. edn 2 (1742) 526; Fl. Zeyl. (1747) 103], Sp. Pl. 2 (1753) 625; Gen. Pl. edn 5 (1754) 274; Burman f., Fl. Ind. (1768) 132; Gaertner, Fruct. Sem. Pl. 1 (1788) 268, t. 56, f. 5; A.L. Juss., Gen. Pl. 2 (1789) 108; Lour., Fl. Cochinch. 2 (1790) 376; Necker, El. Bot. 1 (1790) 356; Schreb., Gen. Pl. 2 (1791) 412; Roxb., Pl. Corom. 2 (1798) 32, t. 162; Willd., Sp. Pl. 3 (1800) 313; A. St. Hil., Expos. Fam. 1 (1805) 248; A.L. Juss., Ann. Mus. 7 (1806) 75; Sprengel, Syst. Veg. 2 (1825) 765; Blume, Bijdr. Fl. Ned. Ind. (1826) 814; Reichb., Consp. Reg. Veg. (1828) 117; Dumort., Anal. Fam. Pl. (1829) 22; Sprengel, Gen. Pl. 2 (1831) 481; Roxb., Fl. Ind. 3 (1832) 82; Endl., Gen. Pl. 2 (1836) 636, no. 3704; Blanco, Fl. Filip. edn 1 (1837) 492; Meisner, Pl. Vasc. Gen. 1, Tab. Diagn. (1840) 291; Pl. Vasc. Gen. 2, Comment. (1840) 200; Spach, Hist. Natur. Veg. Phan. 9 (1840) 232; Endl., Ench. Bot. (1841) 312; D. Dietr., Syn. Pl. 3 (1843) 372, 613; Walp., Rep. Bot. Syst. 4 (1845) 97; Schau. in DC., Prod. 11 (1847) 678; Walp., Ann. Bot. Syst. 3 (1852) 239; Miq., Fl. Ind. Bat. 2 (1858) 865; Benth., Fl. Aust. 5 (1870) 64; L. Pfeiffer, Nomen. Bot. 1, part 2 (1874) 1468; Benth. & Hook. f., Gen. Pl. 2 (1876) 1153; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 378; C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 581; T. Durand, Gen. Phan. (1888) 321; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Briq. in Engl. & Prantl, Plfanzenfam. 4, 3a (1895) 173; F.M. Bail., Qld Fl. 4 (1901) 1177; Dalla Torre & Harms, Gen. Siphon. (1904) 433, no. 7188; H.J. Lam, Verbenac. Malay. Arch. (1919) 214; Bartling, Ord. Natur. Pl. (1830) 180; Junell, Symb. Bot. Ups. 4 (1934) 92; Lemée, Dict. Descrip. Syn. Gen. Pl. Phan. 8b (1943) 656; Mold., Résumé Verbenac. etc. (1959) 276, 297, 298, 318, 320, 395, 397; Backer & Bakh. f., Fl. Java 2 (1965) 606; Mold., Fifth Summary Verbenac. etc. 1 & 2 (1971) 472, 523, 524, 526, 569, 572, 739, 742; Farr & al., Index Nom. Gen. Pl. 2 (1979) 730; Mold., Sixth Summary Verbenac. etc. (1980) 375, 394, 405, 408, 409, 412, 423, 445.

Type: *G. asiatica* L., Sp. Pl. 2 (1753) 626.

Trees or tall shrubs. *Stem* and branches almost cylindrical, glabrous or pubescent with simple hairs. *Leaves* simple, decussate, exstipulate, reticulate-veined, unicostate, petiolate. *Inflorescence* cymose, compound and much branched, terminal, pedunculate. *Flowers* complete, zygomorphic, bisexual, hypogynous; bracts small, narrow. *Calyx* of 4 or 5 fused sepals, persistent, tubular or somewhat campanulate, truncate or 4-5-toothed or sinuate-lobed, scarcely accrescent, generally with large (? nectariferous) glands. *Corolla* of (4-) 5 fused petals, deciduous, tubular below, more or less 2-lipped above, upper lip 2-lobed, lower lip 3-lobed with midlobe largest; tube narrow at base, much dilated upwards, infundibuliform with wide throat. *Stamens* 4, slightly exserted above the corolla-tube or almost included, didynamous, alternate with the corolla-lobes, epipetalous, inserted in the lower part of the corolla-tube; filaments flat, filiform, often sparsely glanduliferous; anthers dorsifixed, oblong or elliptic, 2-lobed, lobes longitudinally dehiscent. *Ovary* bicarpellary, syncarpous, 4-locular, with one ovule in each cell attached to an axile placenta at or above the middle; style filiform, slightly exserted, with two unequal stigmatic lobes. *Fruit* a succulent drupe, with hard endocarp, 4-celled or rarely 2-celled. *Seeds* solitary in each cell, exalbuminous.

Number of species: World ± 33; Australia 5.

Derivation of name

Named after Johann George Gmelin, 1709-1755, German botanist of Tübingen.

Distribution (Map 1)

The genus *Gmelina* is distributed in the tropical and subtropical regions of Australia, Asia and Africa. In temperate regions it is known from Nepal and Southern China. The main distribution, however, extends from India to Indochina and eastwards throughout Malesia and tropical Australia.

Of the five Australian species, two are endemic in Australia and the other three are dispersed in Malesia. Of these, *G. leichhardtii*, is cultivated in Australia and the Hawaiian Islands, and *G. elliptica* in several countries of Asia, Europe, Africa and America.

Affinities

Gmelina is closely related to *Premna* in its inflorescence being terminal; corolla 2-lipped, fertile stamens 4, didynamous; fruit a drupe with 4-celled pyrenes. Nevertheless, it can easily be distinguished by its corolla-tube being large, mostly infundibuliform, greatly enlarged above; style unequally 2-lobed at the apex. *Gmelina* is also closely allied to *Vitex* in having a 2-lipped corolla with a short cylindrical tube, didynamous stamens and drupaceous fruit. The latter, however, can readily be distinguished by its leaves being mostly digitately compound with 3-7 leaflets, rarely 2 or 1, and stigma equally lobed.

Key to the Species

1a. Lamina glabrous; corolla blue, mauve or purple-pink 3

1b. Lamina tomentose below; corolla creamy-white or yellow 2

2a. Scrambling spinescent shrub; lamina with 3 to 4 pairs of nerves, entire or 3-lobed; inflorescence racemiform, 2.5-5 (-7) cm long; corolla yellow with long slender tube, glabrous inside; ovary glabrous; fruit obovoid, yellow .... 1. *G. elliptica*

2b. Tall tree; lamina with more than 4 pairs of veins, entire; inflorescence of loose pedunculate cymes, ± pyramidal in outline, 10-25 cm long; corolla creamy-white with short broad tube, villous inside at the base of stamens; ovary sparsely pubescent; fruit globular, bluish-purple .... 2. *G. leichhardtii*

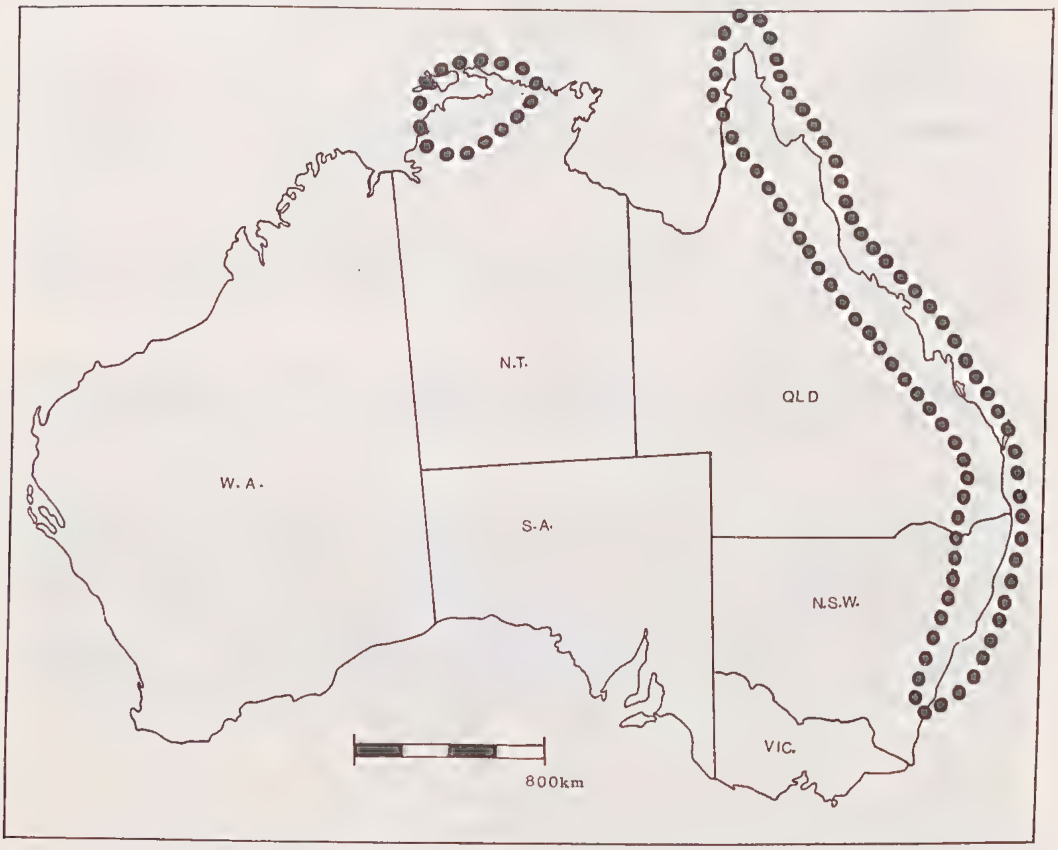
Key to species (*continued*)

3a. Lamina and calyx without nectariferous glands; cymes forming sessile clusters along the rhachis; corolla-tube villous inside at the base of stamens; ovary villous at the top; fruit globular .... 3. *G. fasciculiflora*

3b. Lamina-base and anterior side of calyx with nectariferous glands; cymes pedunculate, lax; corolla-tube glabrous inside; ovary glabrous; fruit obovoid 4

4a. Calyx pubescent outside; ovary often with minute glands at the top........ 4. *G. schlechteri*

4b. Calyx glabrous; ovary without glands at the top .... 5. *G. dalrympleana*



Map 1. Distribution of the genus *Gmelina* L. in Australia.

1. **Gmelina elliptica** J.E. Smith in Rees, Cycop. 16 (1810) no. 2; Merr., Enum. Philip. Fl. Pl. 3 (1923) 399; Meeuse, Blumea 5 (1942) 73; Mold., Résumé Verbenac. etc. (1959) 55, 142, 157, 163, 166, 176, 178, 180, 184, 186-193, 195-197, 199, 218, 296, 297, 341; Fifth Summary Verbenac. etc. 1 & 2 (1971) 100, 230, 264, 276, 283, 296, 301, 305, 317, 320, 325, 330, 332, 334, 363, 523, 524, 615; Phyt. Mem. 2 (1980) 93, 220, 253, 263, 273, 275, 286, 289, 293, 296, 298, 307, 311, 315, 320, 322, 324, 354, 408, 627.

Type: East Indies, undated (LINN, holotype. Microfiche!).

[*Radix deiparae spuria* Rumph. Herb. Amb. 2 (1741) 124, t. 39.]

Type: n.v., only the above cited tab. 39 seen on microfiche.

G. villosa Roxb., Hort. Beng. (1814) 46, *nom. nud.*; Fl. Ind. edn 2, 3 (1832) 86; Walp., Rep. Bot. Syst. 4 (1845) 98; Schau. in DC., Prod. 11 (1847) 679; Miq., Fl. Ind. Bat. 2 (1858) 867; Suppl. 1 (1861) 242; F.-Vill., Novis App. (1880) 159; C.B. Clarke in Hook. f., Fl. Br. Ind. 4 (1885) 582; Vidal, Rev. Pl. Vasc. Filip. (1886) 210; Kuntze, Rev. Gen. Pl. (1891) 507; Koord. & Val., Bijdr. Boom. Java 7 (1900) 197; Merr., Philip. Bureau Forest. Bull. 1 (1903) 51; Dict. Pl. Names Philip. Isl. (1903) 153; Rev. Sp. Blanc. Fl. Filip. (1905) 68; King & Gamble, J. As. Soc. Beng. 74 (1908) 824; Merr., Interp. Rumph. Herb. Amb. (1917) 454; H.J. Lam, Verbenac. Malay. Arch. (1919) 217; Jack, Descrip. Malay. Pl. No. 1 (1820) 17; Ridley, Fl. Malay. Pen. 2 (1923) 623; Hook., Bot. Misc. 1 (1830) 284; Dop. Fl. Gen. Indochin. 4 (1935) 846; Fletcher, Kew Bull. (1938) 423.

Type: *Roxburgh s.n.*, cultivated in Botanic Garden at Calcutta, undated, (possibly in K, n.v.). The plant is said to be a native of Pulo Pinang, from where it was introduced by Dr W. Hunter into the Botanic Gardens at Calcutta in 1802.

G. asiatica sensu Wall. Cat. (1828) No. 1818, p.p.; sensu Kurz, For. Fl. Br. Burma 2 (1877) 265, non Linn.; sensu Blanco, Fl. Filip. edn 1 (1837) 492, non Linn.; ed 2 (1845) 344.

G. asiatica L. var. *villosa* (Roxb.) Bakh. in van Leeuwen et al., Bull. Jard. Bot. Buitenz. Ser. III, 3 (1921) 70; Bakh. & H.J. Lam in van Leeuwen et al., Bull. Jard. Bot. Buitenz. Ser. III, 4 (1922) 285; Heyne, Nutt. Pl. Ned. Ind. edn 2 (1927) 1320.

Type: as for *G. villosa* Roxb., Fl. Ind. 2 (1832) 86.

Description (Fig. 1)

A scrambling spinescent shrub or small tree, (1.5-) 2.5-5 (-8) m high. *Stem* with olive-coloured bark; branchlets spreading and drooping, spinescent, fulvous-villous; spines axillary, straight, 0.5-2 cm long. *Leaves* elliptic, ovate or somewhat trapeziform, blunt or slightly pointed at apex, cuneate towards the base, entire or sometimes acutely 3-lobed, chartaceous, (3-) 5-9.5 cm long, (2-) 3-5 (-6) cm broad, the upper surface pubescent when young, glabrous and dark-coloured when old, the lower surface fulvous-tomentose, pairs of veins 3 to 4; petiole slender, fulvous-pubescent, channelled above, (1-) 1.5-3 (-4) cm long. *Inflorescence* racemiform, 2.5-5 (-7) cm long, fulvous-tomentose. *Flowers* very shortly pedicellate, golden-yellow; pedicels 1.5-2.5 mm long, fulvous-tomentose; bracts ± leafy, caducous, lanceolate or ovate-lanceolate, acuminate or cuspidate, 1-2 cm long, 4-8 mm broad. *Calyx* campanulate, with 4 small teeth on top, 3-4 (-5) mm long, 3-4 mm in diameter, persistent, slightly expanded under the fruit, with 3-6 nectariferous glands on the anterior side, densely pubescent outside, glabrous within. *Corolla* yellow, membranous, 4-lobed, softly pubescent outside, glabrous inside, (3-) 3.5-4.5 cm long; upper lip entire, 6-7 mm long, 8-12 mm broad at the base; lower lip 3-lobed, the middle lobe (i.e. the lowest lobe) largest, broadly ovate-oblong, 1-1.7 cm long, 9-12 mm broad, the lateral lobes ± rounded in outline, 5-10 mm long, 8-12 mm broad at the base; tube very slender below for up to half its length, then abruptly and obliquely dilating upwards, several times longer than the calyx, 2-2.5 (-2.8) cm long, 1-1.5 cm broad at top, 2-2.5 mm in diameter in the lower slender portion. *Stamens* almost included, inserted about the middle of the corolla-tube near the top of slender portion; filaments filiform, with glandular hairs, the anterior pair longer, 1.6-2 cm long, the lateral pair 8-10 mm long; anthers oblong, lobes free and divergent in the lower halves, 1.5-2.5 mm long, 1-2 mm broad, the longest pair with their

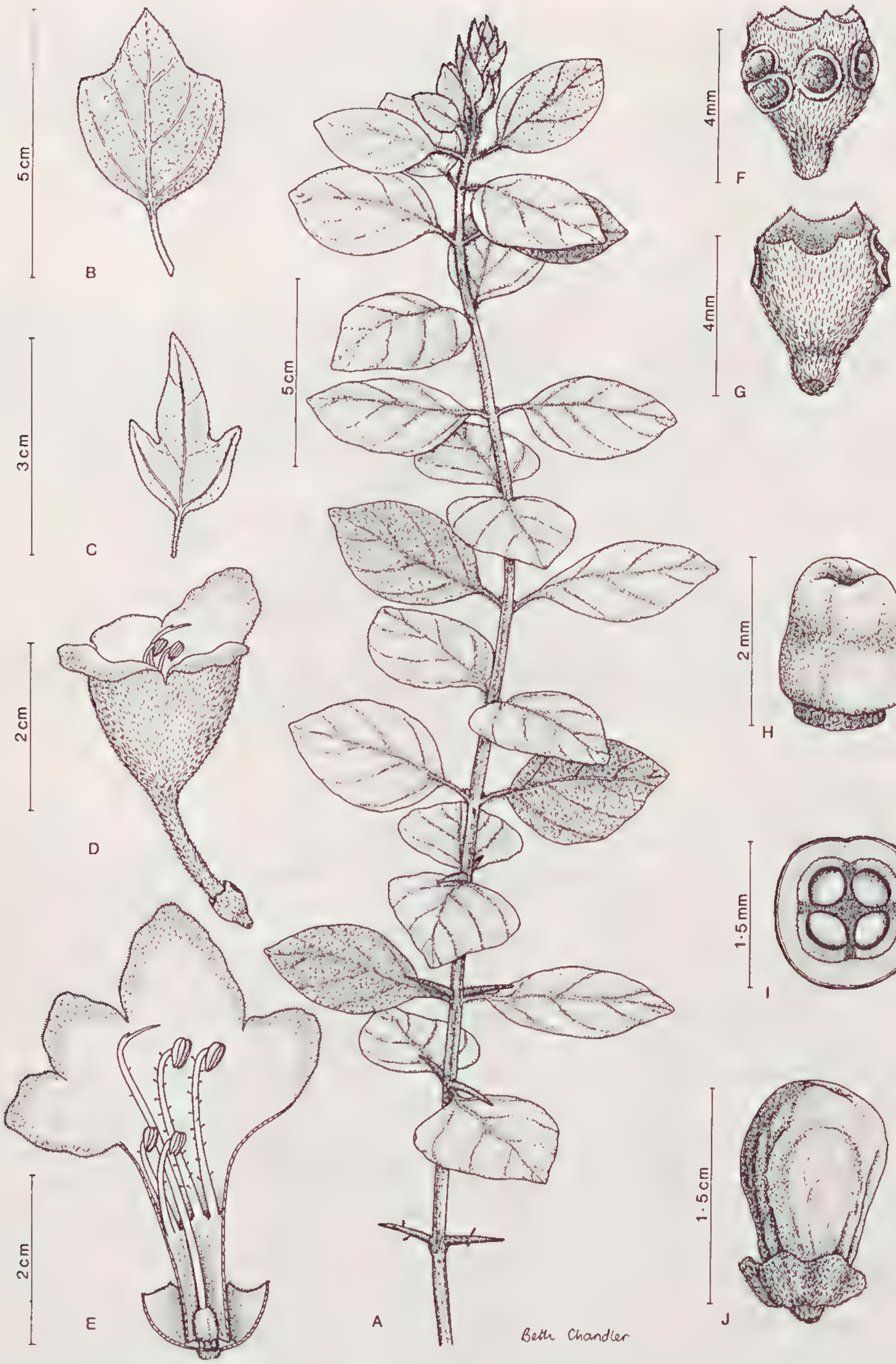


Fig. 1. *Gmelina elliptica* J.E. Smith (A & D-I, *S.E. Duenas s.n.*: PNH 23099; B, C & J, *S.L. Everist s.n.*: BRI 141090). A, habit drawing of a branch; B & C, lobed leaves; D, flower; E, flower vertically cut open to show androecium and gynoecium; F, calyx showing nectariferous glands on the anterior face; G, calyx showing nectary free posterior face; H, ovary; I, transverse section of ovary; J, fruit with persistent calyx.

connectives much enlarged on the back. *Ovary* obovoid-globose, glabrous, 1.5-2.5 mm long, 1-2 mm in diameter; style slightly exserted, filiform, glabrous or with sparsely glandular hairs, 2.5-3.7 cm long, stigma unequally 2-lobed. *Fruit* globose-obovoid, (1-) 1.5-2 cm long, 0.8-1.3 cm in diameter, glabrous, fleshy, yellow when ripe.

Specimens examined

AUSTRALIA: QUEENSLAND: *Everist s.n.*, Splitter Creek, Yeppoon-Rockhampton road, 19 km from Rockhampton, 5.vi.1972 (BRI 141090); *Lands Department s.n.*, Yeppoon, 23° 08'S, 150° 45'E, iv.1971 (BRI 118988).

INDONESIA: *Asdat 191*, Sumatra, Atjeh, Koeala Kepong, O. van Troemon, 2.ix.1941 (BO, BRI, SING); *Henderson 20147*, Anambas Island, 31.iii.1928 (BRI, SING); *Kornassi 1079*, Ambon, Moluccas, 2.iv.1918 (BO, BRI); *Meijer 10184*, Celebes, Central part, Kulora near Palu, 18.v.1975 (BO, L, MO, US); *Posthumus (2) 266*, Celebes, Donggala, 3.xi.1930 (BO); *Rahmat 1120*, Sumatra, East Coast, Hessa Asahan, 27.viii.1928 (MICH, SING); *Rahmat 3603*, Sumatra, Langgapajoeng, 7-30.iii.1933 (MICH, QRS); *Rahmat 3962*, Sumatra, Kajoe Garijang, Kota Pinang, 15 April-16 May, 1933 (MICH, QRS); *van Steenis 9315*, Sumatra, Atjeh, Gajolanden, 26.ii.1937 (BO, BRI, SING).

MALAYA: *Burkill & Shah HMB 290*, Pangkor Island, Parak, 10.vii.1955 (BRI, SING); *Corner s.n.*, Kemamau, Tringganu, 29.vii.1932 (SING); *Ridley s.n.*, Selandor, Malacca, 7.vi.1890 (SING); *Ridley s.n.*, Kuala Pahang, Pahang, May 1890 (SING).

SINGAPORE: *Choa Chuking s.n.*, 1896 (SING); *Leg ? s.n.*, Botanic Garden, 10.ix.1889 (MEL, SING).

BORNEO: *Henderson SF 38965*, Kalawat, N. Borneo, 8.iv.1950 (SING).

PHILIPPINES: *Edano 8871*, Cabucan Island, Sulu Prov., 16.ii.1957 (PNH); *Santos E. Duenas s.n.*, Bo. Matuya-tuya, Torrijos Marinduque Island, 3.vii.1955 (PNH 23099); *Fenix s.n.*, Tanculan, Bukidon sub. Province, Mindanao, vii.1916 (BRI, PNH 26124); *Frake 232*, Mampay, Zamboanga del Norte Mindanao, 4.x.1957 (PNH); *Kellman ANU 1595*, Coronon Valley near Santa Cruz, Davao Prov., Mindanao, iii.1964 (CANB); *Pascua s.n.*, Basilan and Zamboanga, Mindanao, ii.1926 (BRI, PNH 30231); *Piper 128*, Oroquieta Prov. Mindanao, iv.1911 (BRI, PNH); *Robinson s.n.*, Bulalaeao Mindoro, ' 14-24.iii.1909 (BRI, PNH 6692, MEL 583541); *Salaudin s.n.*, Basilan, Basilan, xii.1930 (PNH 31384, SING); *Sulit s.n.*, Bo. Manaul, Mansalay, Mindoro, xii.1952 (PNH 17009); *Taleon s.n.*, Bagacay, Pototan, Iloilo Prov., 19.viii.1953 (PNH 22267).

Distribution (Map 2)

In Australia, *G. elliptica* is known only from Queensland, where it occurs in the coastal area around Rockhampton and Yeppoon. Collections from overseas have been examined from all over Malesia excepting New Guinea. H.J. Lam (1919) gave its distribution as being from Nicobar, Burma, Siam, Malay Peninsula and Archipelago, Philippines, Palau Islands and Indonesia. In addition to the above localities, Moldenke (1971, 1980) recorded it from Jamaica, Belgian Congo, Mauritius, India, Indochina, Caroline Island and Riouw Archipelago. It is likely that the records of this species from Jamaica, Congo and Mauritius may have resulted from cultivated plants.

Comments

The first and the only Australian record of *G. elliptica* is made here from near Rockhampton in Queensland. So far, it has not been recorded from any part of New Guinea, therefore, its occurrence in Australia may possibly be an escape from cultivation. However, according to a collector's note with one of a Lands Department Collection in Herb. BRI (No. BRI 118988), this species is so well established in one part of the State that "it has become a problem on property near Yeppoon". It is the only Australian *Gmelina* with scrambling habit, spinescent branchlets, small elliptic leaves, golden-yellow corolla and yellow fruit. The spine-like axillary thorns are in fact the abortive branchlets, some of them with rudimentary buds or leaves. The corolla seems to be the longest of all Australian species, with a long slender tube abruptly dilating above the middle.

Of the many specimens examined from overseas, and two from Australia, no collection has noted the precise period of flowering and fruiting for the species. There is also no such

mention in the recent literature. According to Roxburgh (1832), however, the trees of this species, cultivated in the Botanic Gardens at Calcutta, are in flower and fruit all the year round.

Moldenke (1971, 1980) states that this species is cultivated in Java, India, England, Belgium, Congo, Mozambique, Zaire, Zanzibar, Brazil, Porto Rico, Florida, Hawaiian Islands and Tahiti.

The plant is said to have various medicinal use by the natives in Malaya and Indonesia.

Map 2. Distribution of *G. elliptica* +; *G. leichhardtii* △; *G. fasciculiflora* ●; *G. schlechteri* □; *G. dalrympleana* ○ in Australia.

Affinities

G. elliptica is nearest to *G. leichhardtii* in its lamina being tomentose below; calyx pubescent outside; filaments with sparse glandular hairs; fruit glabrous. However, *G. elliptica* can easily be distinguished by its scrambling shrubby habit, spinescent branchlets, both entire and 3-lobed leaves each with 3-4 pairs of main nerves, racemiferous inflorescence, nectariferous calyx, 4-lobed yellow corolla, long and slender corolla-tube which is several times longer than calyx and glabrous inside, more distinctly didynamous stamens, glabrous ovary and yellow obovoid fruit. There are several characters common between *G. elliptica* and *G. schlechteri*. In both species, calyces are with nectariferous glands; calyx and corolla pubescent outside, glabrous within; filaments with glandular hairs; ovary glabrous and fruit obovoid. The latter, however, may readily be identified by its habit being a tall tree; leaves large with lamina (10-) 15-25 (-36) cm long, glabrous all over, with nectariferous gland at the base and pairs of main nerves more than 4; inflorescence large, lax, ± pyramidal, 15-25 (-30) cm long; calyx-tube truncate; corolla mauve or pale-lilac, distinctly 5-lobed, 1.5-2.5 cm long, tube short and broad; fruit reddish-purple or purple-pink.

2. **Gmelina leichhardtii** (F. Muell.) Benth., Fl. Aust. 5 (1870) 66; Hill, Coll. Qld Timber (1880) 16; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 379; Moore, Cens. Pl. N.S.W. (1884) 52; Nilson, Timb. Trees N.S.W. (1884) 84; Keys, Proc. Roy. Soc. Qld 2 (1885) 48; F.M. Bail., Qld Woods (1888) 91; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; F.M. Bail., Cat. Indig. & Natur. Pl. Qld (1890) 35; Briq. in Engl. & Prantl. Pflanzenfam. 4, 3a (1895) 173 in obs.; F.M. Bail., Qld Fl. 4 (1901) 1178; Maiden & Betche, Proc. Linn. Soc. N.S.W. 27 (1902) 62; Maiden, For. Fl. N.S.W. 1 (1904) 185, t. 33; Dixon, Pl. N.S.W. (1906) 235; Maiden, J. & Proc. Roy. Soc. N.S.W. 42 (1908) 110; F.M. Bail., Comp. Cat. Qld Pl. (1913) 386; Maiden & Betche, Cens. N.S.W. Pl. (1916) 178; Maiden, N.S.W. For. Handb. part 2 (1917) 205, t. 33; Francis, Aust. Rain-For. Trees (1951) 367, figs. 231, 232; Forest & Timber Bureau, For. Trees Aust. (1957) 202; Mold., Résumé Verbenac. etc. (1959) 209, 297, 385; R.H. Hend., Trees N.S.W. edn 4 (1968) 254; Hall et al., For. Trees Aust. (1970) 286; Mold., Fifth Summary Verbenac. etc. (1971) 346, 363, 523, 524, 720; Maiden, Usef. Nat. Pl. Aust. rep. edn (1975) 549; Wrigley & Fagg, Aust. Nat. Pl. (1979) 335, 336; Mold., Sixth Summary Verbenac. etc. (1980) 337, 354; Bains, Aust. Pl. Gen. (1981) 167; Beadle et al., Fl. Syd. Reg. edn 3 (1982) 510.

Type: *L. Leichhardt s.n.*, Myall Creek, New South Wales, 20.xi.1843 (MEL 583165, lectotype designated here!). *H. Beckler s.n.*, Clarence River, New South Wales, undated (MEL 583164, syntype!).

Vitex leichhardtii F. Muell., Fragm. 3 (1862) 58, basionym; F. Muell., Fragm. 6 (1868) 153.

Type: As for *G. leichhardtii* (F. Muell.) Benth.

Typification

G. leichhardtii is based on two (syntype) collections, one by Dr Ludwig Leichhardt (s.n., MEL 583165) from Myall Creek, and another by Dr Herman Beckler (s.n., MEL 583164) from Clarence River. Both collections come from New South Wales and are apparently without any duplicate. Since the original author (F. Mueller) did not choose a type, it is, therefore, proposed to select a lectotype for this species. Annotations by F. Mueller indicate that he did examine both the syntypes in MEL. Of these, the one collected by L. Leichhardt (s.n., MEL 583165) is particularly complete and well preserved and is selected here as the lectotype.

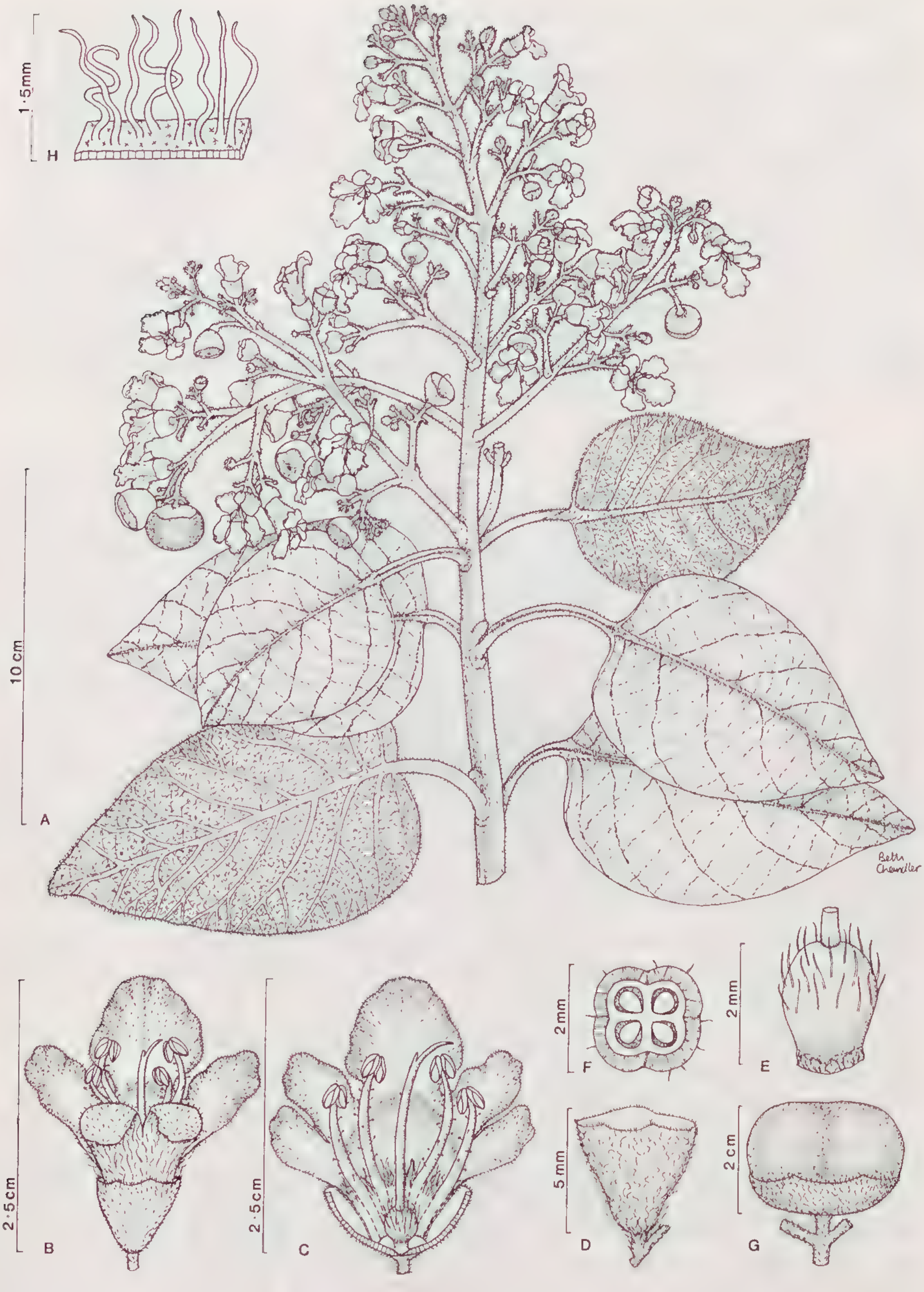


Fig. 2. *Gmelina leichhardtii* (F. Muell.) Benth. (A-H, *A.A. Munir 5575 & L. Haegi*: AD). A, flowering branch; B, flower; C, flower with calyx and corolla vertically cut open to show androecium and gynoecium; D, calyx; E, ovary; F, transverse section of ovary; G, fruit; H, portion of leaf showing hairs on the abaxial surface.

Description (Fig. 2)

A large tree attaining a height of 30 (-40) m. *Stem* up to 1.21 m diameter near the base; bark grey or dark grey, the old ones often flaky, fissured or irregularly tessellate; young branches light brown, tomentose. *Leaves*: lamina narrowly elliptic or ovate-elliptic, with rounded or somewhat cuneate base, narrowed towards the apex but not acuminate, entire, (6-) 8-15 (-23) cm long, (4-) 6-10 (-14) cm broad, somewhat coriaceous, glabrous above, densely tomentose underneath, veins very prominent and raised on the lower surface; petiole fairly thick, tomentose, (1.5-) 2-4 (-5.5) cm long. *Inflorescence* much branched, tomentose, ± pyramidal in outline, 10-25 cm long, nearly as broad towards the base; cymes opposite, pedunculate. *Flowers* shortly pedicellate; pedicels hairy, 2-3 mm long. *Calyx* broadly turbinate-campanulate, truncate, pubescent outside, glabrous within, 4-6 mm long, 3-5 (-6.5) mm across the top, persistent, accrescent and spreading under the fruit, 1-1.8 cm diameter in fruit. *Corolla* creamy-white, the middle lobe of the lower lip bluish with yellow blotch at the base, and with two bluish streaks extending down the tube ending in a yellow blotch at the base of two anterior stamens, villous-tomentose outside, glandular-pubescent on the inner face of the lobes, glabrous inside the tube excepting the narrow villous hairy ring at the base of stamens, 2.3-2.5 cm long; the upper lip 2-lobed, lobes oblong, 7-9 mm long, 5-6 mm broad; the lower lip 3-lobed, the middle lobe ovate, 8-10 mm long, 7-10 mm broad, the lateral lobes elliptic-oblong, (5-) 7-10 mm long, 5-6 mm broad; tube very broad and abruptly dilating above the calyx, 6-8 mm long, nearly as broad at the mouth. *Stamens* exserted, inserted near the base of the corolla-tube; filaments incurved in the upper half, sparsely covered with gland-tipped hairs, the anterior pair longer, 12-13 mm long, the lateral pair 10-11 mm long; anthers ± oblong, lobes free and divergent in the lower half, narrowing towards the free end, 1.5-2 mm long, 0.5-1 mm broad. *Ovary* globular, sparsely pubescent, becoming glabrous later, 1-2 mm in diameter; style exserted, incurved in the upper half, glabrous, 11-16 mm long, stigma unequally 2-lobed, the smaller lobe about one-tenth the length of the longer. *Fruit* nearly globular, broader than long, depressed, succulent, glabrous, bluish-purple when ripe and fresh, (1.5-) 2-2.5 cm in diameter.

Representative specimens (collections seen: Australian 51, non-Australian 0)

AUSTRALIA: QUEENSLAND: *Bailey s.n.*, Enoggera Creek, x.1875 (BRI 266993); *Cameron s.n.*, Yarraman, ix.1924 (BRI 266995); *Clemens s.n.*, Dalrymple Heights, Eungella, vii-xi.1947 (BRI 019235); *J. Dallachy s.n.*, Rockingham Bay, undated (MEL 583486, MEL 583493); *Domin 8158*, Tambourine Mts, iii.1910 (PR); *Francis s.n.*, Eungella Range, via Mackay, 3-12.x.1922 (BRI 266991-2); *Griffith s.n.*, Pioneer River, 1889 (MEL 527843); *Hyland 9126*, Mt Blackwood, 21° 03'S, 148° 56'E, 11.x.1976 (QRS); *McDonald, Fisher & Ryan 3244*, Bulburin State Forest, 24° 03'S, 151° 02'E, 17.iv.1980 (BRI); *Stockill s.n.*, Fraser Island, ii.1972 (BRI 133520); *Telford 1464*, D'Aguilar Range, Mt Glorious, 19.ii.1970 (CBG); *Webb & Tracey 7665*, Cawley State Forest west of Cathu, between Mackay & Proserpine, vi.1965 (BRI); *White s.n.*, Samford, undated (BRI 266994); *White 12639*, loc. cit. 6.iv.1945 (BRI).

NEW SOUTH WALES: *Bauerlen 14*, Shoalhaven River, vi.1888 (MEL 583492); *Beckler s.n.*, Clarence River, undated (MEL 583164, *syntype*); *Beuzeville 758*, Woolgoolga, 9.x.1934 (NSW 145018); *Blakely, Shires & Batt s.n.*, Head of Patonga Creek, 6.ix.1925 (NSW 145020); *Boutcher s.n.*, Dunoon, ii.1958 (NSW 145023); *Burgess s.n.*, Coff's Harbour, 26.x.1966 (CBG 018298); *Coveny s.n.*, Wherrol Flat, near Wingham, 11.i.1967 (NSW 145016); *Downmy s.n.*, Deep Creek, near Valla Beach, 24.v.1922 (NSW 145027); *Edwards s.n.*, Richmond River, x.1888 (MEL 527844); *Hay 1497*, Murwillumbah, ii.1912 (NSW 145024); *Jones 2654*, Toonumbar S.F., Kyogle, 6.ii.1964 (CANB); *Jones s.n.*, Tweed River, Dec. 1966 (CANB 189175, CANB 189181); *Leichhardt s.n.*, Myall Creek, 20.xi.1843 (MEL 583165, *lectotype*); *Judd s.n.*, Minnamurra Falls, iv.1953 (NSW 145022); *Martin Poll Samp. 1368*, Lion Park, a few miles N of Lismore, 10.xi.1967 (SYD); *Moore 146 s.n.*, Clarence River, undated (MEL 513487-89); *Phillips s.n.*, Nambucca Heads, iii.1940 (NSW 145011); *Rodway 1865*, Upper Williams River, 18.viii.1935 (K, NSW); *Rudder s.n.*, Port Macquarie, undated (NSW 145014); *Wheen 484*, between Urunga and Nambucca, 6.ii.1945 (NSW); *Wilshire s.n.*, near Grafton, 3.iii.1905 (NSW 145026).

Distribution (Map 2)

G. leichhardtii is endemic in Australia where the main distribution is in the eastern coastal part of Queensland and New South Wales. Within this area, the northern-most locality is near Rockingham Bay in Queensland and the southern-most along the Shoalhaven River in New South Wales. In the south, it is fairly evenly distributed along the coast but to the north it seems to be more abundant in the McPherson Range and to the west of Mackay in the Eungella Range. From outside the mainland of Australia, it is known only from Fraser Island in Queensland. According to Moldenke (1971), *G. leichhardtii* has been cultivated in Hawaiian Islands and New South Wales. During present investigations, this species was found to have been cultivated in the Botanic Gardens of Adelaide, Brisbane, Melbourne, Sydney and the Waite Agricultural Research Institute at Glen Osmond, South Australia.

Comments

G. leichhardtii is named after Dr Ludwig Leichhardt, an explorer and botanist, who collected the type specimen from northern New South Wales. The authorship to the combination of its name has been referred by Moldenke (1959, 1971, 1980) and a few others to F. Mueller who originally described it as *Vitex*. According to present investigations, however, it was first transferred to the genus *Gmelina* by Bentham (1870).

The plant is popularly called "White Beech" or "Native Beech", and has a very juicy fruit with disagreeable taste. Generally, the leaves are entire-margined but sometimes they are distinctly toothed at the juvenile stage.

According to Francis (1951), "the timber is one of the most useful of Australian scrub woods. It is durable, easy to work, and does not shrink very much. It is used for almost all indoor purposes such as furniture-making, general fitting, and wood-carving. Owing to the high reputation of the timber in the past and present, it is not plentiful now".

Affinities

G. leichhardtii is closely allied to *G. elliptica*. For details see "affinities" under the latter. There are also several characters common between *G. leichhardtii* and *G. fasciculiflora*. Both have their lamina and calyx free of nectariferous glands, corolla-tube villous inside at the base of stamens, ovary villous at the top, fruit globular in shape and purple-mauve when ripe and fresh. The latter, however, can readily be identified by its lamina being glabrous, not cuneate towards the apex; cymes forming sessile clusters along the rhachis; corolla blue or mauve-purple, with tube almost twice the length of calyx.

According to H.J. Lam (1919), *G. leichhardtii* has affinities with *G. lepidota* Scheffer. The former species, however, is a tree and differ from the latter in the texture of leaves and in the dimensions of calyx and corolla. *G. lepidota* is a climbing shrub with glabrous shining leaves which are scaly beneath and acute at the base and apex.

3. **Gmelina fasciculiflora** Benth., Fl. Aust. 5 (1870) 65; F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 378; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; F.M. Bail., Cat. Indig. & Natur. Pl. Qld (1890) 35; Qld Fl. 4 (1901) 1178; Comp. Cat. Qld Pl. (1913) 386; Francis, Aust. Rain-For. Trees (1951) 454, Fig. 270; Mold., Résumé Verbenac. etc. (1959) 209; Fifth Summary Verbenac. etc. 1 & 2 (1971) 346, 523; Sixth Summary Verbenac. etc. (1980) 337; Bains, Aust. Pl. Gen. (1981) 167.

Type: *J. Dallachy s.n.*, Rockingham Bay, Queensland, Australia, 16.x.1868 (MEL 583159, lectotype designated here!). *Dallachy s.n.*, loc. cit. (Muenga Creek), 9.ix.1865 (MEL 583160, syntype!). *Dallachy s.n.*, loc. cit., 24.x.1865 (MEL 583161, syntype!). *Dallachy s.n.*, loc. cit., undated (K, MEL 583158, MEL 583162, MEL 583163—syntypes!).

Vitex leichhardtii F. Muell. var. *glabrata* F. Muell., pro syn. apud Benth., Fl. Aust. 5 (1870) 65.

Typification

G. fasciculiflora is based on several of J. Dallachy's collections from Rockingham Bay, Queensland. These collections collectively consist of at least 23 duplicates of which 7 specimens were certainly seen by Bentham while preparing the protologue of this species. However, he did not designate any one of these as a type. It is, therefore, necessary to choose a lectotype for this name. With the exception of one syntype at Kew, all other types are preserved in Herb. MEL. Of these, the one with number MEL 583159 was definitely seen by Bentham in preparing the original description of this species. The specimen is particularly complete and well preserved, and is, therefore, selected here as the lectotype.

Description (Fig. 3)

A tree (4-) 10-25 (-30) m high. *Stem* often straight, without prominent buttresses, glabrous, (12-) 20-80 cm diameter, bark grey, somewhat scaly; young shoots densely clothed with rust-coloured short hairs. *Leaves* ovate-elliptic, obtuse or obtusely acuminate, with rounded or somewhat cuneate base, entire, (3-) 5-12 (-16) cm long, (2.5-) 4-7 (-9) cm broad, glabrous, somewhat coriaceous, shining above, the primary veins more prominent on lower surface; petiole glabrous, 0.5-2 (-3) cm long. *Inflorescence* ± pyramidal in outline, densely ferruginous-tomentose, 10-20 (-25) cm long, 8-15 cm across towards the base; cymes more or less sessile, reduced to dense opposite globose clusters along the rhachis. *Flowers* shortly pedicellate; pedicels densely ferruginous-tomentose, 0.5-3 mm long; bracts ovate-elliptic, tomentose abaxially, glabrous adaxially, ± 2 mm long, ± 1.5 mm broad. *Calyx* broadly campanulate, almost truncate or with 5 minute lobes at the rim, ferruginous-villous outside, glabrous within, 2.5-4 mm long, 2.5-3.5 mm broad at the top, persistent, accrescent and spreading under the fruit, enlarging to 15 mm. *Corolla* blue or mauve-purple with a yellow marking on the lower lobe, densely ferruginous-villous outside, papillose on the inner face of the lobes, glabrous inside the tube excepting the narrow villous hairy ring at the base of stamens, 10-16 (-20) mm long; upper lip 2-lobed, lobes ovate-oblong, 3-6 (-7) mm long, 3-5 (-6) mm broad near the base; lower lip 3-lobed, the middle lobe broadly elliptic-ovate, with a yellow marking, 5-8 (-10) mm long, 5-7 (-8) mm broad, the lateral lobes oblong-ovate, 4-6 (-8) mm long, 3-5 (-6) mm broad; tube oblique, abruptly dilating above the calyx, 5-8 mm long, 4-7 mm broad at the top. *Stamens* exserted, inserted near the base of the corolla-tube; filaments filiform, incurved in the upper half, sparsely covered with gland-tipped hairs, anterior pair 10-11 mm long, lateral pair 8-9 mm long; anthers more or less oblong, 1.5-2 mm long, ± 1 mm broad, lobes free and divergent in the lower halves, narrowing towards the free end. *Ovary* globular, villous at the top, glabrous elsewhere, 1-2 mm diameter; style exserted, incurved in the upper half, often glanduliferous, but becoming glabrous later, 12-15 mm long, stigma very unequally 2-lobed, the smaller lobe one-tenth to one-twentieth the length of the longer lobe. *Fruit* globular, succulent, glabrous, bright violet or purplish-mauve when ripe, smooth and shiny, 1-2 cm diameter, wrinkled and black when dry.

Representative specimens (collections seen: Australian 55)

AUSTRALIA: QUEENSLAND: *Bailey 79*, Mts Torrens and Sophia, 1904 (BRI); *Cowley 11a*, Martintown, 17° 01'S, 145° 02'E, undated (BRI); *Crome 556*, Lacy Creek, Mission Beach, 6 km W of Clump Point, 17° 50'S, 146° 05'E, 15.xi.1972 (CANB); *Dallachy s.n.*, Rockingham Bay, 16.x.1868 (MEL 583159, lectotype!); *Dallachy s.n.*, loc, cit. undated (MEL 583158, MEL 583162, MEL 583163—syntypes); *Dallachy s.n.*, loc. cit., Meunga Creek, 9.ix.1865 (MEL 583160, syntype); *Dallachy s.n.*, loc. cit., 24.x.1865 (MEL 583161, syntype); *Dallachy s.n.*, loc. cit., undated (MEL 583145-48, MEL 583150, MEL 583152-54, MEL 583156-57, possible syntypes); *Dreghorn 6512*, Gadgarra Forest Reserve, 17° 18'S, 145° 44'E, 9.i.1934 (BRI); *Fitzsimon 163*, State Forest Reserve 755, 17° 26'S, 145° 46'E, 12.xi.1976 (QRS); *Gray 222*, Julatten, 16° 37'S, 145° 22'E, 11.i.1977 (QRS, 3 spec.); *Hunter 6455*, banks of the Barron River, 16° 52'S, 145° 42'E, 30.xi.1939 (BRI); *Hyland 1310*, State Forest Reserve 94, 17° 15'S, 145° 25'E, 11.iii.1968 (QRS); *Hyland 5605*, S.F.R. 756, East Downey L.A., 17° 40'S, 145° 50'E,

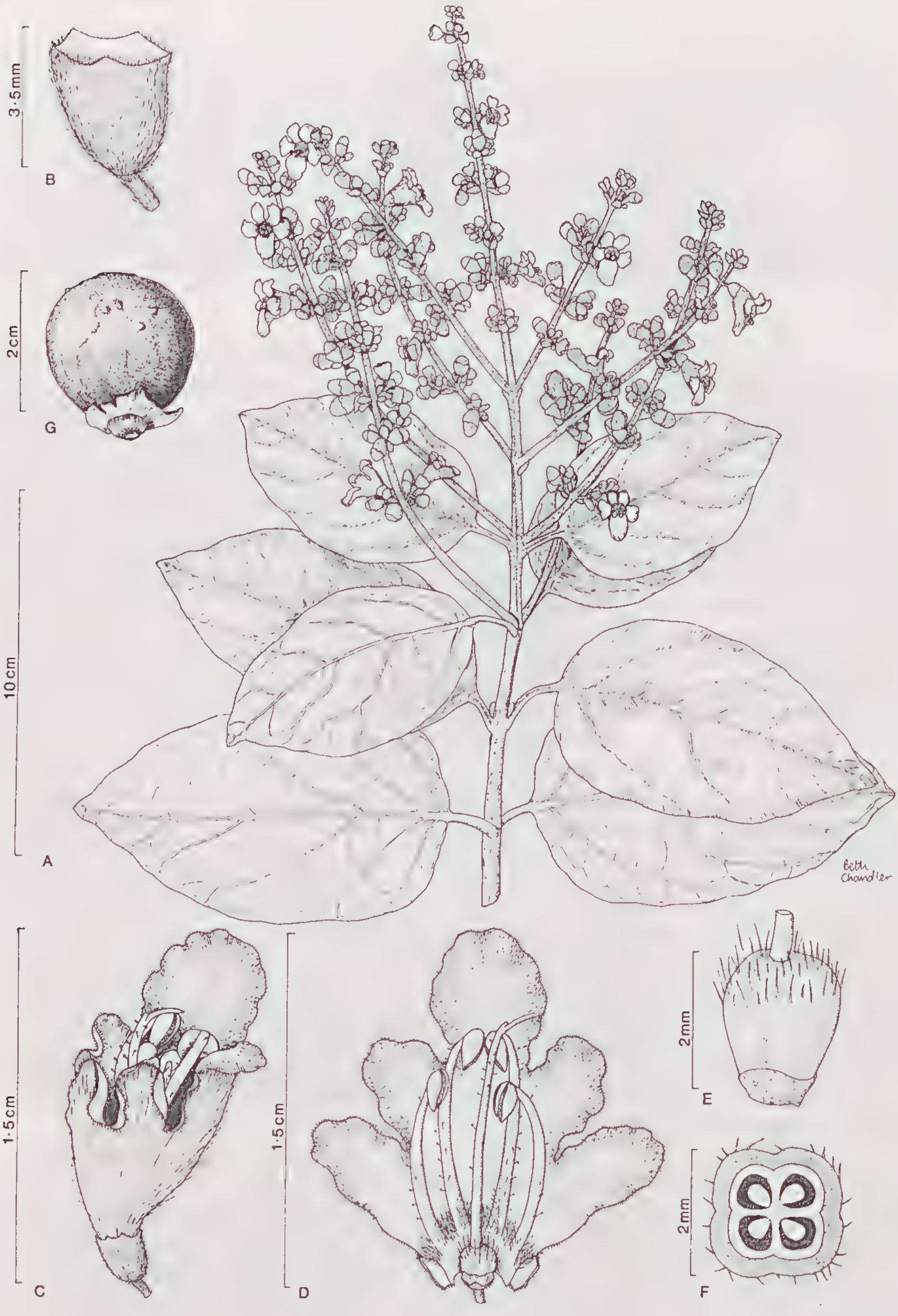


Fig. 3. *Gmelina fasciculiflora* Benth. (A-F, *B. Hyland 6486*: QRS; G, *A. Irvine 443*: QRS). A, flowering branch; B, calyx; C, flower; D, flower vertically cut open to show androecium and gynoecium; E, ovary, F, transverse section of ovary; G, fruit with persistant calyx.

1.xi.1971 (BRI 2 spec., QRS 3 spec.); *Hyland 6486*, S.F.R. 191, Barron, 17° 20′S, 145° 30′E, 15.xi.1972 (BRI, CANB, QRS); *Irvine 443*, Boonjie T.R. 1230, 17° 25′S, 145° 45′E, 23.i.1973 (BRI, CANB, QRS 3 spec.); *Irvine 1718*, Daintree River, south side near ferry, 16° 16′S, 145° 25′E, 17.xii.1975 (QRS); *Irvine 1725*, Carrington Falls near S.F.R. 194, 17° 20′S, 145° 25′E, 5.i.1976 (BRI, QRS 2 spec.); *Kajewski 1337*, Range Road, Atherton Tableland, 7.xi.1929 (BRI); *Ladbrook s.n.*, Johnstone River, xi.1917 (BRI 267153, BRI 267155); *Manuell 14*, Ravenshoe, N. Qld, undated (BRI); *Michael s.n.*, Johnstone River, ix.1917 (BRI 267160); *Moriarty 2086*, S.F.R. 755, TR 1230, Boonjie L.A., 17° 22′S, 145° 45′E, 9.vi.1976 (QRS); *Risley 172*, EP/14, S.F.R. 185, 17° 10′S, 145° 35′E, 24.i.1975 (BRI, NSW, QRS); *Risley 476*, Python L.A., 17° 10′S, 145° 37′E, 9.ii.1978 (AD, QRS); *Sanderson 1455*, S.F.R. 185, Python L.A., 17° 10′S, 145° 37′E, 23.v.1978 (QRS); *Smith 4899*, Fenby's Gap, 17° 52′S, 146° 05′E, 31.x.1951 (BRI); *Stocker 618*, S.F.R. 185, Danbulla near Gilmore's Plot, 17° 10′S, 145° 35′E, 15.iii.1971 (BRI, QRS); *Thorsborne 141*, Galmara, Meunga Creek, Cardwell, 18° 14′S, 146° 00′E, 23.i.1976 (BRI); *Webb & Tracy 11639*, 16° 55′S, 145° 15′E, x.1973 (BRI); *Webb & Tracey 6589*, Gregory Falls—lower Palmerston via Innisfail, 1962 (BRI); *Winter s.n.*, Purtaboi Island, 17° 55′S, 146° 10′E, 11.v.1975 (QRS 002741-42).

Distribution (Map 2)

G. fasciculiflora is endemic in northern Queensland, Australia, where it is restricted between latitudes 16° and 19°S, and longitudes 145° and 147°E. The major distribution is on the Atherton Tableland extending from Rockingham Bay northwards to Daintree River. Most localities are in the coastal rain-forest region, and so far it has not been recorded from the interior of the State.

Comments

All of Dallachy's collections of this species came from the same general locality, but none of them has any collection number. The following 7 specimens, however, are found to have different collecting dates: MEL 583149 (5 Nov. 1865), MEL 583151 (Nov. 1864), MEL 583155 (16 Oct. 1865), MEL 583159 (16 Oct. 1868), MEL 583160 (29 Sept. 1865), MEL 583161 (24 Oct. 1865), K s.n. (1869 Comm.). These seem to belong to different Dallachy collections. The remaining undated and un-numbered 16 specimens may possibly belong to the same collections. However, if they are an assemblage of different collections, there seems no way to find out the likely duplicates of any one collection. In all, 19 specimens of Dallachy's collections of this species (in Herb. MEL) are found in the type folders. Six of them are labelled "syntype" and the remaining 13 as "possible syntype".

In the protologue of this species, Bentham (1870) cited the type: "Rockingham Bay, Dallachy", without selecting any specimen as the type. According to present investigations, Bentham examined only the following 7 herbarium specimens of this taxon in preparing the original description: K s.n., MEL 583158, MEL 583159, MEL 583160, MEL 583161, MEL 583162 and MEL 583163. All these are labelled as "syntype". Since there is no authentic duplicate of these syntypes, therefore, status of Dallachy's other collections from Rockingham Bay, labelled "possible syntype", remains doubtful. To avoid further confusion, a lectotype is chosen here from amongst the 7 specimens (syntypes) seen by Bentham. The remaining 6 specimens being the authentic syntypes or isolectotypes.

In the synonymy of this species, Bentham (1870) cited "*Vitex leichhardtii* var. *glabrata* F. Muell.", and the same was recorded by Bailey (1901). This variety, however, has not been found to have been validly published in the available literature.

Under the "remarks" on the label of G. Stocker's collection (no. 618: QRS), the fruit is described as "1″ diameter". Such a large sized fruit has not been found among the many collections examined here. The biggest fruit seen by the present author measures up to 2 cm in diameter.

According to Francis (1951), the general aspect of the *G. fasciculiflora* tree, the character of the bark and the appearance of the wood strongly resemble those of the Australian White Beech, *Gmelina leichhardtii*. The wood is cream-coloured, firm, compact, close-grained without pattern or sheen.

The species name has apparently been drawn from the clusters of flowers along the rhachis of the inflorescence. It is popularly called "North Queensland Beech" or "Gray Teak".

Affinities

Amongst the Australian *Gmelina* species, *G. fasciculiflora* is closely allied to *G. leichhardtii* in its lamina and calyx being free of nectariferous glands, corolla-tube villous inside at the base of stamens, ovary villous at the top, fruit globular in outline and purple-mauve when fresh. Nevertheless, *G. fasciculiflora* may easily be distinguished by its lamina's being glabrous, not cuneate towards the apex; cymes forming sessile clusters along the rhachis; corolla blue or mauve-purple, with tube almost twice the length of calyx. According to Francis (1951), these species resemble each other in general aspect, the character of the bark and the appearance of the wood.

G. fasciculiflora has several characters common with *G. dalrympleana* and *G. schlechteri*. All three have a glabrous lamina which is not cuneate towards the apex, blue or mauve corolla with tube twice as long as the calyx. However, the latter two can readily be identified by their lamina-base and calyx having nectariferous glands, cymes pedunculate and lax, corolla-tube glabrous inside, ovary glabrous and fruit obovoid.

4. **Gmelina schlechteri** H.J. Lam, Verbenac. Malay. Arch. (1919) 226.

Type: *R. Pullen 7662*, Nunumai, c. 12 km N of Amazon Bay, Central District, Papua New Guinea, 21.vi.1969 (CANB, neotype designated here; A, BO, BRI, CANB, K, L, LAE, PNH, TNS - isoneotypes).

G. dalrympleana (F. Muell.) H.J. Lam var. *schlechteri* (H.J. Lam) Mold., Phytologia 4 (1953) 178; Résumé Verbenac. etc. (1959) 201-203, 297; Fifth Summary Verbenac. etc. 1 & 2 (1971) 333, 336, 338, 524; Sixth Summary Verbenac. etc. (1980) 323, 327, 328.

Type: As for *G. schlechteri* H.J. Lam.

G. macrophylla auct. non Benth.: Schumann in Schumann & Hollr., Fl. Kais.-Wilh. land (1889) 120, quoad spec. *Hallrung no. 651*, Augusta Station, New Guinea.

Typification

G. schlechteri was described by H.J. Lam (1919) on F.R.R. Schlechter's collection no. 17042 from New Guinea. The whereabouts of its type, however, has not been mentioned in the protologue. During the present investigation, *Gmelina* material has been examined from 23 herbaria, including B, BM, BO, BR, BRI, K, L, LAE and SING, but the type of this species has not been found. Perhaps it was deposited in Herb. B, and was destroyed during the second World War. In view of this a neotype is selected here.

Of all the specimens of *G. schlechteri* examined from New Guinea, the specimen collected by R. Pullen (no. 7662), now preserved in Herb. CANB, is very typical of this species. It conforms in all details with H.J. Lam's description, and is, therefore, designated here as the neotype.

Description (Fig. 4)

A tree 8-20 (-29) m high. *Stem* erect, young branches glandular and pubescent, the main trunk glabrous, with smooth grey or tessellated rough brown bark. *Leaves* broadly elliptic-oblong or obovate-oblong, entire, obtuse or shortly acuminate, truncate or somewhat cuneate at the base, rarely rounded, with a pair of nectariferous glands at the base of the lamina below the first pair of nerves, (10-) 15-25 (-36) cm long, (5-) 10-20 (-25) cm broad, coriaceous, glabrous, dull, green above, pale beneath; primary nerves

Fig. 4. *Gmelina schlechteri* H.J. Lam (A-G, *D.A. Hearne 103*: DNA: H, *M. McKean B809*: CANB). A, flowering twig; B, flower; C, flower vertically cut open to show androecium and gynoecium; D, calyx showing pubescence outside and nectary free posterior face; E, calyx showing nectariferous glands on the anterior face; F, ovary; G, transverse section of ovary; H, fruit with persistant calyx.

sub-pubescent, prominent on the lower surface; petiole glandular and pubescent, becoming glabrescent later, (1.5-) 2.5-4.5 (-8) cm long. *Inflorescence* ± pyramidal, 15-25 (-30) cm long, 10-18 (-20) cm in diameter, ferruginous- or cinereous-pubescent. *Flowers* sessile or with a minute pubescent pedicel of 1-1.5 mm long; bracts caducous, elliptic or elliptic-oblong, densely pubescent abaxially, glabrous adaxially, 2-5 mm long, 1.5-3 mm broad. *Calyx* campanulate, truncate or obsoletely 5-dentate, densely pubescent outside, glabrous inside, with nectariferous glands on the anterior side, 3-4 (-5) mm long, 3 (-4) mm broad at the top, persistent, somewhat accrescent and expanded under the fruit. *Corolla* mauve or pale lilac, appressedly pubescent outside, glabrous inside the tube, papillose on the inner faces of lobes, 1.5-2.5 cm long; upper lip 2-lobed, lobes oblong to ovate-oblong, 5-7 mm long, 3.5-5 mm broad; lower lip 3-lobed, the middle lobe oblong-ovate, with a yellow spot inside at the base, the lateral lobes oblong or oblong-ovate, 5-7 mm long, 3-5 mm broad; tube oblique, abruptly dilating above the calyx, (7-) 10-12 mm long, (5-) 7-10 mm broad at the top end. *Stamens* ascending under the upper lip, somewhat exserted, inserted in the lower part of the corolla-tube; filaments filiform, flattened, incurved and with glandular hairs in the upper half, anterior pair 8-11 mm long, the lateral pair 6-9 mm long; anthers with fairly thickened connective on the back, 1.5-2.5 mm long, 1-1.5 mm broad; lobes oblong, free and divergent in the lower half. *Ovary* obovoid-globose, glabrous with often small deciduous glands at the top, 1.5-2 mm long, 1-1.5 mm in diameter in the upper half; style exserted, incurved in the upper half, filiform, with glandular hairs, 15-20 mm long, stigma unequally 2-lobed. *Fruit* obovoid, truncate or with a small knob on top, glabrous, (8-) 10-15 (-17) mm long, (6-) 8-11 mm in diameter distally, reddish-purple or purple-pink and glossy when fresh, turning black and dull when dry.

Representative specimens (collections seen: Australian 20, non-Australian 12)

AUSTRALIA: NORTHERN TERRITORY: *Byrnes 228*, Koolpinyah, 1.vi.1951 (DNA); *Byrnes 1666*, 8 miles N.E. of Wangi H.S., 25.viii.1969 (DNA, NT); *Blake 17169*, between Gerowie Creek and Mary River, 4.x.1946 (BRI); *Dunlop 3665*, Koolpinyah, 10.x.1974 (DNA, NT); *Dunlop 5601*, Green Ant Creek, East Spring, 28.xi.1980 (AD, DNA); *Hearne 103*, Bamboo Creek Wangi, 21.x.1972 (DNA); *Hearne 111*, Mount Tolmer, 21.x.1972 (DNA); *Holtz 45*, Port Darwin, 1883 (MEL 3 spec.); *Martensz 304*, c. 5 m E Nourlangie Rock, 10.xi.1972 (CANB, DNA, K, NT); *J. McKean B735*, Bamboo Creek, 22 m W Batchelor, 20.x.1972 (DNA); *M. McKean B809*, 2 m N Mt Brockman Range, 11.xi.1972 (CANB, DNA, NT); *Parker 515 & 525*, "The Pine", Douglas River, 24.x.1974 (BRI, DNA, MO, NT); *Parker 1159*, Kemp Airstrip area, 9.i.1978 (BRI, DNA, NT); *Reeve, Bona & Wurrapali 570*, between Nangalala and Ramanginin, 9.i.1973 (CANB, 2 spec.); *Robinson R939*, Bamboo Creek, Marrakai tract, 20.x.1964 (DNA); *Stocker 513*, Maningrida, v.1963 (NT); *Stocker & Fox 464*, Banjo Jungle, Melville Island, 27.iv.1966 (BRI, NT); *Telford & Wrigley 7879*, Gulungul Creek, Kakadu National Park, 5 km WSW of Mt Brockman, 21.iv.1980 (CBG).

PAPUA NEW GUINEA: *Carr 15748*, Isuarava, Papua, 24.ii.1931 (CANB); *Hollrung 651*, Augusta Station, 1887 (B, MEL 2 spec.); *Johns NGF 47311*, Paiawa, Morobe Sub-District, 12.v.1970 (A, BRI, CANB, K, L, LAE); *Kairo NGF 17260*, Maigo, near Marshall Lagoon, Central District, 18.x.1963 (A, BRI, CANB, K, L, LAE, PNH, SING, US); *Kerenga & al. LAE 73871*, Opo Creek, near Anna Village, Prov. Morobe, 4.iii.1978 (A, BRI, CANB, E, K, L, M); *Millar NGF 22979*, Bupu Village, Wampit, Morobe District, 13.vii.1967 (BRI, L, LAE); *Pullen 7662*, Nunumai, c. 12 km N of Amazon Bay, 12.vi.1969 (CANB, neotype; A, BO, BRI, K, L, LAE, PNH, TNS, isoneotypes); *Smith NGF 1345*, Eastern district, Milne Bay, near Mapo, -.iii.1945 (CANB, LAE); *Turner 128*, Fife Bay, Papua, -.xi.1930 (BRI 2 spec.); *Coll. ign. NGF 4167*, Sogeri, Central District, undated (BRI).

INDONESIA: MOLUCCAS: *Buwalda 5431*, Aroe Island, P. Trangan, 1.vii.1938 (BO, BRI).

Distribution (Map 2)

In Australia, *G. schlechteri* is found only in the Northern Territory where it occurs chiefly in the north-west between latitude 12° and 14°S, and longitude 130° and 133°E. Within this area the main concentration of this species is in the tropical forest of Darwin region. Besides this there is one locality near Maningrida along the northern coast, and one in Banjo Jungle on Melville Island.

Collections from overseas have been examined from Papua New Guinea and Aroe Island in the Moluccas.

Comments

G. schlechteri is recorded for Australia for the first time. Previously all Australian collections of this species were identified as *G. dalyrmpleana* (F. Muell.) H.J. Lam or *G. macrophylla* (R. Br.) Benth. Moldenke (1953) relegated *G. schlechteri* to a variety of *G. dalrympleana* without giving any reason. As a result of the present investigations, however, *G. schlechteri* is reinstated to species rank because it differs from *G. dalrympleana* in its densely pubescent calyx and apically sparsely glandular ovary. In all other characters, they are very close to each other.

The species was named after the German botanist, F.R.R. Schlechter who collected its type from Kaui Mountains, New Guinea. The type is not found in any of those herbaria where Schlechter's collections are likely to be deposited.

Affinities

G. schlechteri is nearest to *G. dalrympleana* in its lamina's being glabrous and having two nectariferous glands at the base; cymes pedunculate, lax; corolla-tube glabrous inside; ovary glabrous; fruit obovoid. Nevertheless, *G. schlechteri* may easily be identified by its calyx being densely pubescent and ovary sparsely glandular at the top. There is also a close relationship between *G. schlechteri* and *G. ledermanni* H.J. Lam. Both species have glabrous leaves with nectariferous glands at the base of the lamina, pyramidal inflorescence, pedunculate cymes and pubescent calyx. The latter, however, can easily be distinguished by its leaf-margin's being slightly curved, corolla yellow, and ovary with "stiff" hairs at the top.

5. **Gmelina dalrympleana** (F. Muell.) H.J. Lam, Verbenac. Malay. Arch. (1919) 223; C. White, Proc. Roy. Soc. Qld 38 (1927) 259; Junell, Symb. Bot. Ups. 4 (1934) 92; Mold., Résumé Verbenac. etc. (1959) 201, 202, 209, 285, 296, 297, 386; Fifth Summary Verbenac. etc. 1 & 2 (1971) 336, 338, 346, 491, 523, 524, 716; Chipp., Proc. Linn. Soc. N.S.W. 96 (1972) 256; Mold., Sixth Summary Verbenac. etc. (1980) 327, 328, 337, 409; Bains, Aust. Pl. Gen. (1981) 167; N. Beadle, Veg. Aust. (1981) 180.

Type: *J. Dallachy s.n.*, Rockingham Bay, Queensland, Australia, undated (MEL 583504, lectotype designated here!; MEL 583498, MEL 583505-583508, MEL 583512-583514, MEL 583516-583519, MEL 583521, syntypes!). *Dallachy 34*, loc. cit., 29.i.1864 (MEL 583497, syntype!). *Dallachy s.n.*, loc. cit., 16.xii.1864 (MEL 583503, syntype!). *Dallachy s.n.*, loc. cit., 8.vii.1864 (MEL 583509, syntype!). *Dallachy s.n.*, loc. cit., 5.ii.1864 (MEL 583511, syntype!). *Dallachy s.n.*, loc. cit., 14.xii.1865 (MEL 583520, syntype!).

Vitex dalrympleana F. Muell., Fragm. 4 (1864) 128, **basionym**; Fragm. 5 (1865) 72.

Type: As for *G. dalrympleana* (F. Muell.) H.J. Lam.

G. macrophylla (R. Br.) Benth., Fl. Aust. 5 (1870) 65, *nom. illeg.*, non Wall. ex Schau. (1847); F. Muell., Syst. Cens. Aust. Pl. 1 (1882) 103; F.M. Bail., Synop. Qld Fl. (1883) 378; F. Muell., Descrip. Notes Pap. Pl. 8 (1886) 46; Qld Woods (1888) 91; Maiden, Usef. Nat. Pl. Aust. (1889) 550; F. Muell., Sec. Syst. Cens. Aust. Pl. 1 (1889) 173; Schumann in Schumann & Hollr., Fl. Kais.-Wilh-land (1889) 120, excl. *Hollrung* 651; F.M. Bail., Cat. Indig. & Natur. Pl. Qld (1890) 35; Schumann & Lauterb., Fl. D. Schutzgeb. Südsee (1901) 524; Banks & Sol., Ill. Aust. Pl. Cook's voy. part 2 (1901) 74, t. 238; F.M. Bail., Qld Fl. 4 (1901) 1178; Pulle in Lorentz, Nova Guinea 8 (2) (1910) 402; F.M. Bail., Comp. Cat. Qld Pl. (1913) 386; Ewart & O.B. Davies, Fl. N. Terr. (1917) 238; H.J. Lam & Bakh., Bull. Jard. Bot. Buitenz. Ser. 3 (1921) 68; Bakh., J. Arn. Arb. 10 (1929) 72, excl. descrip.; Junell, Symb. Bot. Ups. 4 (1934) 92; Beer & H.J. Lam, Blumea 2 (1936) 226; Francis, Aust. Rain-For. Trees (1951) 454.

Type: *J. Banks & D. Solander s.n.*, Cape Grafton, Queensland, Australia, 1768-1771 (BM, holotype!).

Vitex macrophylla R. Br., Prod. Fl. Nov. Holl. (1810) 512, basionym of *G. macrophylla* (R. Br.) Benth. (1870); Schau. in DC., Prod. 11 (1847) 695; Seemann, J. Bot. 3 (1865) 258; F. Muell., Fragm. 6 (1868) 153.

Gmelina vitiensis Seemann, Mission to Viti 1860-61 (1862) 440, *nom. nud.*; Mold., Résumé Verbenac. etc. (1959) 207, 391; Fifth Summary Verbenac. etc. 1 & 2 (1971) 343, 731, **syn. nov.**

Ephielis simplicifolia Sol. ex Seemann, J. Bot. 3 (1865) 258; Fl. Viti. part 5 (1866) 189.

Type: As for *G. macrophylla* (R. Br.) Benth.

Vitex vitiensis Seemann, Fl. Viti. part 5 (1866) 190, t. 45, **syn. nov.**

Type: "*Milne s.n.*, Viti, locality not specified", undated (K, n.v.).

Typification

G. dalrympleana is based on several of J. Dallachy's collections from Rockingham Bay, Queensland. These collections collectively consist of at least 19 duplicates of which 13 were certainly seen by F. Mueller while preparing the original description of this species. However, he did not designate any one of these as a type. It is, therefore, necessary to choose a lectotype for this name. All these syntypes are preserved in Herb. MEL. One of these, numbered MEL 583504, is particularly complete and well preserved, and is, therefore, selected here as the lectotype for this species.

Description (Fig. 5)

A tall shrub or small tree (2-) 4-15 (-25) m high. *Stem* straight, glabrous, 10-40 cm diameter, with bark often greyish and cracked or fissured. *Leaves* broadly ovate, ovate-oblong or elliptic-obovate, entire, obtuse or subobtusely acuminate, somewhat cuneate, rounded or cordulate at base, with a pair of nectariferous glands at the base of the lamina below the first pair of nerves, (6-) 10-25 (-36.5) cm long, (5-) 7-15 (-23) cm broad, coriaceous, glabrous but not shining; primary nerves more prominent on lower surface, glabrous or sparsely pubescent; petiole glabrous or puberulous when young, (0.5-) 1-2.5 (-4) cm long. *Inflorescence* more or less pyramidal, 12-25 (-30) cm long, 6-15 (-20) cm across; cymes in axils of foliaceous bracts. *Flowers* almost sessile or shortly pedicellate; pedicels glabrous, 1-1.5 mm long; bracts caducous, oblong-ovate, glabrous, 2-5 (-8) mm long. *Calyx* "dark blue", campanulate, truncate or somewhat sinuate, often irregularly cleft, glabrous, with nectariferous glands on the anterior side, 4-5 (-6) mm long, 3-3.5 mm broad at the top, persistent, somewhat accrescent and expanded under the fruit. *Corolla* purple-pink or blue with yellow throat and mauve lip, appressedly pubescent outside excepting lower part of the tube, glabrous inside the tube, papillose on the inner faces of the lobes, 1.5-2.5 (-3) cm long; upper lip 2-lobed, lobes oblong, (5-) 6-9 mm long, 4-5 mm broad; lower lip 3-lobed, the middle lobe oblong, with a yellow marking at the base, (7-) 8-10 mm long, 5-6 mm broad, the lateral lobes oblong-ovate, 5-9 mm long, 3.5-5 mm broad; tube oblique, abruptly dilating above the calyx, 8-13 mm long, (6-) 7-9 mm broad distally. *Stamens* ascending under the upper lobes, exserted, inserted in the lower part of the corolla-tube; filaments filiform, flattened, incurved in the upper half, glabrous, sometimes with glandular hairs in the upper third, anterior pair 9-13 mm long, lateral pair 7-11 mm long; anthers with fairly thickened connectives, lobes oblong, free and divergent in the lower half, 2-2.5 mm long, 0.5-1 mm broad. *Ovary* oblong-obovoid, glabrous, 1.5-2 mm long, 1-1.5 mm in diameter; style exserted, incurved in the upper half, filiform, sparsely glanduliferous, (1.2-) 1.5-2 cm long, stigma unequally 2-lobed. *Fruit* obovoid-truncate, glabrous, (0.8-) 1-1.5 (-1.8) cm long, (5-) 7-10 (-12) mm in diameter, soft, pink scarlet or red, drying black.

Representative specimens (collections seen: Australian 59, non-Australian 17)

AUSTRALIA: QUEENSLAND: *Armit 89*, Mulgrave River, undated (MEL); *Bailey 35*, Somerset, vi.1897 (BRI); *Bailey 92*, Thursday Island, vi.1897 (BRI); *Bouel 10*, Endeavour River, i.1881 (MEL); *Brass 2185*, Daintree River, 28.ii.1932 (BRI); *Cameron 2057, 2072 & 2036*, Horn Island, 23.vii.1975 (QRS); *Cameron 20535, 20550 & 20610*, Moa Island, 22.ii.1975 (QRS); *Cameron 2698, 2714 & 272081*, Badu Island, 22.xii.1976 (QRS);

Fig. 5. *Gmelina dalrympleana* (F. Muell.) H.J. Lam (A-H, *L.J. Brass 8539*: CANB). A, flowering branch; B, flower; C, flower vertically cut open to show androecium and gynoecium; D, calyx showing nectariferous glands on the anterior side; E, calyx showing nectary free posterior side; F, ovary; G, transverse section of ovary; H, fruit with persistant calyx.

Cameron 20416, Prince of Wales Island, 15.ii.1975 (QRS); *Cameron & Upton s.n.*, Iron Range, 9.iv.1964 (BRI 266988, CANB 148096); *Flecker 12648*, Turtle Bay, 23.i.1949 (QRS); *Gull s.n.*, Cape York, 12.xii.1867 (MEL 583502, MEL 583510); *Hyland 2472*, Lockerbie, 23.xi.1962 (BRI 2 spec.); *Hyland 291*, Claudie River, 25.x.1973 (BRI, QRS); *Hyland 10970*, near Bamaga, 4.xii.1980 (AD, QRS); *Irvine 1958*, Jardine River, 18.x.1979 (QRS); *Jago 199*, Cairns, 10.xii.1978 (QRS); *Kajewski 1466*, Daintree River, 12.xii.1929 (BRI); *Moriarty 2543*, Whyanbeel Creek between Dayman Point and Newell, 26.xi.1978 (AD, QRS); *Persietz s.n.*, Cooktown, 1877 (MEL 583523); *Sayer s.n.*, Beach mouth of Russell River, 1887 (MEL 1021551); *Smith 12390*, Bamaga Mission, 24.x.1965 (BRI); *Specht W170*, 13.5 km ENE of Weipa Mission, 9.xii.1974 (BRI); *Stocker 1375*, Saibai, 17.vii.1975 (QRS); *Thompson 50*, Lockhart River, undated (BRI); *Webb 3130*, Goanna Creek, E of McIlwraith Range, xi.1956 (BRI); *Webb 3225*, Slopes of Iron Range, xi.1956 (BRI); *Whitehouse s.n.*, Dalhunty River, west (Gulf) side of Cape York Peninsula, undated (BRI).

PAPUA NEW QUINEA: *Bauerlen s.n.*, Fly River, 1885 (MEL 583529, MEL 583530, MEL 583537); *Brass 5753*, Oriomo River, Western Division, i-iii.1934 (BRI); *Brass 6319*, Daru Island, 10.iii.1936 (A, BRI, CANB, LAE); *Brass 7666*, Lake Daviumbu, Middle Fly River, ix.1936 (A, BRI, CANB); *Brass 8539*, Tarara, Wassi Kussa River, xii.1936 (A, BRI, CANB); *Henty NGF 49595*, Mabadauan, Daru subdistrict, 9.vi.1973 (BRI, CANB, L, LAE); *Royen 4891*, Merauke, c. 15 km NE of Koembe Village, 7.ix.1954 (CANB, L); *K.J. White & E. Gray 10374*, Oriomo River, i.1959 (BRI, CANB, LAE).

Distribution (Map 2)

In Australia, *G. dalrympleana* is found only in Queensland where it occurs chiefly in the northern and eastern parts of Cape York Peninsula. Within this area, the main concentration of this species is on the Atherton Tableland and the northern-most part of the Peninsula. Only two localities are on the west (Gulf side) coast of the Peninsula, located north-east of Weipa Mission. There are also several records from the Torres Strait Islands of which one came from Saibai Island close to the Papua New Guinea shore, and others from the Prince of Wales Island, Thursday Island, Horn Island, Badu Island and Moa Island.

From outside Australia, specimens have been examined from Papua New Guinea and Irian Jaya, Indonesia.

In addition to the above localities, Moldenke (1959, 1971) recorded it from the Northern Territory in Australia, but this has not been confirmed. It is possible that Moldenke mistook for this a closely related species *G. schlechteri* H.J. Lam which is now known to occur in that part of Australia.

Comments

Bentham (1870) regarded *Vitex macrophylla* R. Br. as this species and, therefore, named it *Gmelina macrophylla.* This name was readily accepted for the species by the majority of botanists and is, therefore, found recorded in the majority of publications dealing with Australian Verbenaceae. The name *G. macrophylla*, however, was already applied by Wallich ex Schau. (1847) to a different species in the genus, therefore, Bentham's name became a later homonym and thus illegitimate.

Moldenke (1959, 1971) reduced *G. ledermanni* H.J. Lam to synonymy in *G. dalrympleana.* I have not seen the type of the former, but from its protologue it seems to differ from the latter by its corolla being yellow, calyx pubescent, ovary pilose on top and fruit deep blue. These differences seem good enough to treat *G. ledermanni* as a distinct species.

Two of L.J. Brass's collections (nos 959 & 1376f) from Papua New Guinea were identified by Bakhuizen (1929) as "*G. macrophylla* (R. Br.) Benth". In the description, he mentioned that the leaves were paler beneath, flowers yellow, tinged pink, calyx tomentose and glandular without, ovary hairy on top but becoming glabrous soon, and fruit pale blue. These characters seem to agree more closely with *G. ledermanni* than this species. I have not been able to examine the above-named Brass's collections now preserved in Herb. A, but on the basis of above mentioned characters they do not agree with *G. dalrympleana* (= *G. macrophylla*).

At the base of lamina, the two prominent brown spots are regarded here as nectariferous glands. They are convex on the upper and concave on the lower surface of the leaf. Schumann (1889) called them cavities or ant-hollows, and H.J. Lam (1919) named them as extrafloral nectaries. Schumann (1889) found the leaves of Australian specimens to be lacking glands, but during the present investigation almost all Australian collections of *G. dalrympleana* were found to have glands at the base of their lamina. Similar glands are also found on the anterior face of the calyx-tube. The leaves and calyces of *G. schlechteri* also have similar glands.

One of Banks & Solander's (s.n.) collection from Cape Grafton, Queensland, was described by Robert Brown (1810) as *Vitex macrophylla* R. Br., and the same collection in the BM was later used by Seemann (1865) in describing *Ephielis simplicifolia* Seemann. Since there is no other known duplicate of this collection, therefore, it may be regarded as the holotype for both the names. Both these taxa are now included in the synonymy of *G. dalrympleana.*

Similarly, one of Milne's un-numbered collection from Fiji, with no specified locality, was named by Seemann (1862) as *Gmelina vitiensis* (nom. nud.). In 1866, he identified the same plant as *Vitex*, and described it as a new species *Vitex vitiensis.* Its protologue is accompanied by a coloured plate depicting a habit sketch of a flowering branch and analytical drawings of the flower. Under the description, the author has acknowledged that its truly simple leaves and unequally lobed stigma point to its relationship with *Gmelina.* Nevertheless, he transferred it from *Gmelina* to *Vitex*, and in doing so was possibly influenced by Robert Brown (1810) and F. Mueller (1862) who had earlier each erroneously described one *Gmelina* species as *Vitex.* Seemann (1866) assumed that all other characters in his new species are those of a genuine *Vitex*, and it may be that the species has compound leaves like most of its congeners. During present investigations, however, this assumption has not been confirmed, and *Vitex vitiensis* is found to be conspecific with *G. dalrympleana* (F. Muell.) H.J. Lam. It is, therefore, recorded here as a new synonym of this species. The occurrence of the genus *Gmelina* in Fiji has not been confirmed. The type of *Vitex vitiensis* Seemann, now recognized here as a *Gmelina* species, may have come from a cultivated plant. Since the publication of Seemann's Flora Vitiensis (1865-73), *Gmelina* has never been reported wild from any part of the Fijian Islands.

Moldenke (1959, 1971) regarded *G. schlechteri* as a variety of *G. dalrympleana*, but he did not record its occurrence in Australia. In the present treatment, *G. schlechteri* is re-instated to species rank.

According to Maiden (1889), the wood of this species is a useful timber for flooring boards and planking, the timber closely resembling that of *G. leichhardtii.*

In Australia, this species is popularly called "Dalrymple's White Beech", "Queensland Beech" or "long-leaved *Gmelina*". The only known record of its cultivation is in the Lae Botanical Garden in Papua New Guinea.

Affinities

G. dalrympleana is very closely related to *G. schlechteri.* For similarities and distinguishing characters see "affinities" under the latter. *G. dalrympleana* is also related to *G. fasciculiflora* in its lamina being glabrous, non-cuneate towards the apex, corolla blue with the tube almost twice as long as the calyx. Nevertheless, *G. fasciculiflora* is readily distinguished by its lamina and calyx being without nectariferous glands, cymes in sessile clusters along the rhachis; corolla-tube villous inside at the base of stamens; ovary villous at the top and fruit globular in outline.

H.J. Lam (1919) pointed out that his *G. ledermanni* "has a close resemblance with *G. dalrympleana*, but differs from it by smaller leaves which never have more than two basal glands, its narrower inflorescence, its glabrous calyx, and its yellow corolla". The mention of a "glabrous calyx" seems contrary to the "pubescent calyx" given by Lam himself in the protologue. He also pointed out, that *G. macrophylla* Wall. has "its affinity with *G. dalrympleana*, from which it differs, however, by the texture of the leaves and young parts, obtuse apex, the subequal corolla-lobes, and the yellow (not blue) corolla".

According to White & Francis (1927), their newly described *Gmelina sessilis* is also "allied to *G. dalrympleana* (FvM.) H.J. Lam and to *G. macrophylla* Wall. From the latter it differs in its narrow inflorescence, and from the former in its dense inflorescence".

References

Adanson, M. (1763). Familles des Plantes. Vol. 2: 195-201. (Vincent: Paris).

Bailey, F.M. (1883). Verbenaceae. "A Synopsis of the Queensland Flora": 375-381. (Government Printer: Brisbane).

Bailey, F.M. (1901). Verbenaceae. "The Queensland Flora". Part IV: 1164-1185. (H.J. Diddams & Co.: Brisbane).

Bailey, F.M. (1913). Verbenaceae. "Comprehensive Catalogue of Queensland Plants": 381-387. (Government Printer: Brisbane).

Bakhuizen van den Brink, R.C. (1929). The Verbenaceae of British Papua collected for the Arnold Arboretum by L.J. Brass. *J. Arn. Arb.* 10: 69-75.

Bartling, F.G. (1830). "Ordines Naturales Plantarium". (Dietrich: Goettingen).

Bentham, G. (1870). Verbenaceae. "Flora Australiensis". Vol. 5: 31-70. (L. Reeve & Co.: London).

Bentham, G. & Hooker, J.D. (1876). Verbenaceae. "Genera Plantarum". Vol. 2: 1131-1160. (L. Reeve & Co.: London).

Blanco, F.M. (1837). Didinamia Angiospermia. "Flora de Filipinas. Segun el Sistema Sexuale de Linneo". 484-519. (En la imprenta de Sto. Thomas por D. Candido Lopez: Manila).

Briquet, J. (1895). Verbenaceae. In Engler, A. & Prantl, K., "Die natürlichen Pflanzenfamilien". IV, 3a: 132-182. (Wilhelm Engelmann: Leipzig).

Brongniart, A.T. (1843). "Enumeration des generes de plantes cultivés au Muséum d'histoire naturelle de Paris". (Fortin, Masson & Co.: Paris).

Brown, R. (1810). Verbenaceae. "Prodromus Florae Novae Hollandiae et Insulae Van-Diemen": 510-514. (Richard Taylor & Co.: London).

Burman, N.L. (1786). Didynamia Angiospermia. "Flora Indica": 126-139. (Johannes Schreuder: Amsterdam).

Clarke, C.B. (1885). Verbenaceae. In Hooker, J.D. "The Flora of British India". Vol. 4: 560-604. (L. Reeve & Co.: Ashford).

Dalla Torre, C.G. & Harms, H. (1904). Verbenaceae. "Genera Siphonogamarum ad Systema Englerianum Conscripta": 429-434. (Wilhelm Engelmann: Leipzig).

Dietrich, D.N.F. (1843). Didinamia Angiospermia. "Synopsis Plantarum". Vol. 3: 370-372, 600-620. (B.F. Voight: Weimar).

Dumortier, B.C.J. (1829). Verbenaceae. "Analyse des Familles des Plants": 22. (J. Casterman: Tournay).

Durand, Th. (1888). Verbenaceae. "Index Generum Phanerogamorum": 319-322. (Dulau & Co.: London).

Endlicher, S.L. (1836). Verbenaceae. "Genera Plantarum Secundum Ordines Naturales Disposita". Vol. 1: 632-639. (Fr. Beck: Vienna).

Endlicher, S.L. (1841). Verbenaceae. "Enchiridion Botanicum": 311-314. (Wilhelm Engelmann: Leipzig).

Fletcher, H.R. (1938). The Siamese Verbenaceae. *Kew Bull*: 401-445.

Francis, W.D. (1951). "Australian Rain-Forest Trees": 367-373, 454. (Forestry and Timber Bureau. Government of Australia: Sydney).

Gaertner, J. (1788). "De Fructibus et Seminibus Plantarum". Vol. 1: 266-275. (G.H. Schramm: Tübingen).

Gmelin, J.F. (1791). "Caroli a Linné . . . Systema Naturae" per regna tria naturae, secundum classes, ordines, genera, species . . . (G.E. Beer: Leipzig).

Junell, S. (1934). Zur Gynäceummorphologie und Systematik der Verbenaceen und Labiaten. *Symb. Bot. Upsal.* 4: 1-219.

Jussieu, A.L. de (1789). Vitices. "Genera Plantarum Secundum Ordines Naturalis Disposita": 106-110. (Viduam Herissant & T. Barrois: Paris).

Jussieu, A.L. de (1806). Sur la famille des Plants Verbenacees. *Ann. Mus. Hist. Nat.* Paris Vol. 7: 63-77.

King, G. & Gamble, J.S. (1909). Verbenaceae. "Material for a Flora of The Malayan Peninsula". Vol. 4: 1004-1079. (W. Newman & Co.: London).

Lam, H.J. (1919). "The Verbenaceae of the Malayan Archipelago". (M. De Waal: Groningen).

Lemée, A. (1943). Verbenaceae. "Dictionare descriptif et synonymique des generes de plantes phanerogames". Vol. 8b: 650-657. (Imprimerie Commerciale et Administrative: Brest).

Linnaeus, C. (1753). Didynamia Angiospermia. "Species Plantarum". Edn 1, Vol. 2: 602-639. (Laurentius Salvius: Stockholm).

Linnaeus, C. (1754). Didynamia Angiospermia: "Genera Plantarum". Edn 5: 262-286. (Laurentius Salvius: Stockholm).

Loureiro, J. (1793). Didynamia Angiospermia. "Flora Cochinchinensis". Edn 2, Vol. 2: 455-478. (Haude & Spener: Berlin).

Maiden, J.H. (1889). "The Useful Native Plants of Australia including Tasmania". (Turner & Henderson: Sydney).

Meisner, C.F. (1840). Verbenaceae. "Plantarum Vascularium Genera Secundum Ordines Naturalis Digesta . . .". Vol. 1. "Tabulis Diagnosticis": 290-292. Vol. 2 "Commentarius": 197-200. (Libraria Weidmannia: Leipzig).

Miquel, F.A.W. (1858). Verbenaceae. "Flora Indiae Batavae". Vol. 2: 856-913. (C.G. von Der Post: Amsterdam).

Moldenke, H.N. (1953). Notes on New and Noteworthy Plants. XV. *Phytologia* 4: 173-180.

Moldenke, H.N. (1959). "A Résumé of the Verbenaceae, Avicenniaceae, Stilbaceae, Symphoremaceae, and Eriocaulaceae of the World as to valid Taxa, Geographic Distribution and Synonymy". (H.N. Moldenke: Mountainside, New Jersey).

Moldenke, H.N. (1971). "A Fifth Summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Dicrastylidaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World as to valid Taxa, Geographic Distribution, and Synonymy". Vol. 1 & 2. (H.N. Moldenke: Wayne, New Jersey).

Moldenke, H.N. (1980). "Phytologia Memoirs II. A Sixth Summary of the Verbenaceae, Avicenniacea, Stilbaceae, Chloanthaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the World as to valid Taxa, Geographic Distribution and Synonymy". (H.N. Moldenke & A.L. Moldenke: Plainfield, New Jersey).

Mueller, F.v. (1862). "Fragmenta Phytographiae Australiae". Vol. 3: 58-59 & 168. (Government Printer: Melbourne).

Mueller, F.v. (1864). "Fragmenta Phytographiae Australiae". Vol. 4: 128-129. (Government Printer: Melbourne).

Mueller, F.v. (1868). "Fragmenta Phytographiae Australiae". Vol. 6: 151-158. (Government Printer: Melbourne).

Mueller, F.v. (1882). Verbenaceae. "Systematic Census of Australian Plants". Part 1. Vasculares: 102-103. (McCarron, Bird & Co.: Melbourne).

Mueller, F.v. (1889). Verbenaceae. "Second Systematic Census of Australian Plants". Part 1. Vasculares: 171-173. (McCarron, Bird & Co.: Melbourne).

Munir, A.A. (1982). A Taxonomic Revision of the genus *Callicarpa* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 6(1): 5-39.

Munir, A.A. (1984). A Taxonomic Revision of the genus *Premna* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 7(1): 1-43.

Murray, J.A. (1774). "Caroli a Linné . . . Systema Vegetabilium Secundum Classes Ordines Genera Species cum Characteribus et Differentiis". (J.C. Dietrich: Goettingen).

Neckar, N.J. (1790). "Elementa Botanica Genera Genuina, Species Naturales Omnium Vegetabilium . . . " (Societas Typographica: Neoweda ad Rhenum).

Persoon, C.H. (1797). "Caroli a Linné Systema Vegetabilium Secundum Classes Ordines Genera Species . . . " (J.C. Dietrich: Goettingen).

Persoon, C.H. (1807). Didynamia Angiospermia. "Synopsis Plantarum". Vol. 2: 138-182. (J.G. Cotta: Tübingen).

Poiret, J.L.M. (1823). In Lamark, J.B.P.A.M. & Poiret, J.L.M. "Tableau Encyclopedique et Methodique des trois regnes de la nature. Botanique. vol. 3". (Chez Mme Ve Agasse: Paris).

Reichard, J.J. (1778). Didynamia Angiospermia. "Linné's Genera Plantarum". Edn 7. (Varrentrapp: Frankfurt).

Reichenbach, H.G.L. (1828). Labiatae. "Conspectus Regni Vegetabilis Per Gradus Naturales Evoluti". Part 1: 115-117. (Carolus Cnobloch: Leipzig).

Roxburgh, W. (1832). Didynamia Angiospermia. "Flora Indica". Edn 2. Vol. 3: 1-116. (W. Thacker & Co.: Serampore, Calcutta).

Schauer, J.C. (1847). Verbenaceae. In De Candolle, A., "Prodromus Systematis Naturalis Regni Vegetabilis". Vol. 11: 522-700. (Victoris Masson: Paris).

Schreber, J.C.D. (1791). Didynamia Angiospermia. "Caroli a Linné Genera Plantarum . . . " Edn 8: 381-431. (Warrentrapp & Wenner: Frankfurt a/M).

Schumann, K. & Hollrung, M. (1889). Verbenaceae. "Die Flora von Kaiser Wilhelms Land": 118-122. (Asher & Co.: Berlin).

Scopoli, G.A. (1777). "Introductio ad Historiam Naturalem Sistens Genera Lepidum, Plantarum et Animalium . . .". (W. Gerle: Prague).

Seemann, B. (1862). "An Account of a Government Mission to the Vitian or Fijian Islands in the year 1860-61". (Macmillan & Co.: Cambridge).

Seemann, B. (1865). On *Faradaya*, A New Australian Genus. *J. Bot. London*, 3: 256-259.

Seemann, B. (1866). Verbenaceae. "Flora Vitiensis: A description of the Plants of the Viti or Fiji Islands with an account of their History, Uses, and Properties": 186-191. (L. Reeve & Co.: London).

Spach, E. (1840). "Histoire Naturelle des Vegetaux Phanerogams". Vol. 9: 225-243. (Librarie Encyclopedique de Roret: Paris).

Sprengel, K. (1825). Didynamia Angtiospermia. "Caroli a Linné Systema Vegetabilium". Edn 16, Vol. 2: 747-844. (Dietrich: Goettingen).

Ventenat, E.P. (1799). Pyrenaceae. "Tableau du Régne Végétal". Vol. 2: 315-324. (Imprimerie de J. Drisonnier: Paris).

Walpers, W.G. (1845). Verbenaceae. "Repertorium Botanices Systematicae". Vol. 4: 3-134. (Fr Hofmeister: Leipzig).
Walpers, W.G. (1852). Verbenaceae. "Annales Botanices Systematicae". Vol. 3: 231-240. (Ambrosii Abel: Leipzig).
White, C.T. & Francis, W.D. (1927). Plants collected in Papua by C.E. Lane-Poole. *Proc. Roy. Soc. Qld* 38: 225-261.
Willdenow, C.L. (1800). Didynamia Angiospermia. "Caroli a Linné Species Plantarum . . . ". Edn 4, Vol. 3, Part 1: 2-403. (G.C. Nauk: Berlin).

Acknowledgements

I would like to thank Dr J.P. Jessop for reading the manuscript and making useful suggestions; to Dr H.N. Moldenke for supplying literature and references relevant to this work; to Mrs Beth Chandler for preparing the illustrations, and Miss Barbara Welling for typing the manuscript.

Thanks are also due to the Directors/Curators of the following institutions for the loan of herbarium specimens: ADW, B, BM, BO, BR, BRI, CANB, CBG, DNA, JCT, K, L, LAE, MEL, NSW, NT, PERTH, PNH, PR, QRS, SING, SYD, Z.

Index to Scientific Names

Names

New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked refer to figures and maps.

J. Adelaide Bot. Gard. 7(1): 117-121 (1984

A NEW SPECIES OF *NICOTIANA* (SOLANACEAE) FROM DALHOUSIE SPRINGS, SOUTH AUSTRALIA

D.E. Symon

Agronomy Department, Waite Agricultural Research Institute,
Glen Osmond, South Australia 5064

Abstract

A new species *Nicotiana burbidgeae* Symon is described from northern South Australia, with the chromosome number n = 21.

Introduction

In her recent revision of *Nicotiana* in Australia, Horton (1981) 21 referred to *N. benthamiana* anomalous collections from Dalhousie Springs in the far north of South Australia, *Symon 9294, 9354, 9895*. At the time of her writing, a provisional chromosome number of n = 21 (*N. benthamiana* n = 19) had been obtained, but as the cytological preparation was not ideal a decision on whether this was a new species was deferred. The plant has been again cultivated and Mr Peter Ellis has confirmed that the chromosome number is n = 21. This fact together with various morphological differences persuade me that the taxon is an undescribed species.

Nicotiana burbidgeae Symon, sp. nov.

Nicotiana similis *N. benthamianae* sed basi lignescenti, foliis sessilibus subcordatis succulentis, floribus majoribus quoque tubo calycis 7 cm longo et limbo corollae 5 cm diametro differt. Numerus chromosomatum n = 21.

Type: *D. Symon 9294*, South Australia, south east of Dalhousie Springs complex, low silty terrace along small saline stream, at base of low gypseous creek embankment with grey mudstone. Grid 345710, approx. 26°30 S, 135°30 E. 24.ix.1974 (AD, holo; ADW, CANB, L, MO, NT iso), Figure 2.

Erect leafy herb to at least 75 cm high with several branches near base, ? annual or short lived perennial, lower stems distinctly woody, to 1.5 cm diam. (Figure 1). *Indumentum* on all parts abundant, minute, erect, gland-tipped hairs, some of those on calyx with swollen hemispherical bases (Figure 3). *Leaves* mostly cauline, basal ones to 10 x 7 cm, oval, apex obtuse, base broadly attached, sub-cordate, sessile, leaves of the middle stem region to 6 x 3 cm, rather more obovate, those of the flowering stem region commonly cordate-deltoid, gradually decreasing in size upwards, all rather thick and relatively fleshy. *Inflorescence* of solitary interfoliar flowers distributed along upper parts of leafy stems; pedicels to 12 mm in fruit with distinct articulation at base. *Calyx* to 2 cm long; lobes lanceolate, the upper ¼ free, middle region joined by a distinct intersepalar membrane which extends almost to base of calyx. *Corolla* tube 4-7 cm long, rather variable (see note below), c. 2.5 mm wide at top of calyx, tube proper slightly enlarged around ovary, throat cylinder narrowly tapered upwards to 3-3.5 mm diam., throat cup 5 mm long, symmetrical, marked with green veins which extend to limb; *corolla* limb to 5 cm diam. (closing in bright light), lobes broadly triangular, fused for more than half their length, slightly emarginate at junction of interacuminal membranes forming a pentagonal limb, mid-veins green below. Upper 4 *stamens* subdidynamous in throat cup, fifth stamen c. 12 mm below

Fig. 1. Mature plant at Dalhousie Springs.

Fig. 2. Holotype of *N. burbidgeae Symon 9294* (AD).

the upper four, free filament, c. 1.5 cm long; *ovary* c. 5 mm long, broadly conical, subtended by an orange, fleshy disc; style variable in length to 7 cm long exceeding anthers (see note below), stigma terminal, discoid. *Mature capsule* c. 12 mm long, about equal to enveloping calyx, narrowly ovate to oblong, dehiscing by 2 major and 2 minor fissures. *Seeds* c. 1 mm long, reniform, testa with serpentine wrinkles, Figure 4.

Chromosome number, n = 21 fide P. Ellis, Voucher ADW.

Distribution: South Australia, south east end of the Dalhousie Springs complex.

Notes

As discussed by Horton (1981) p. 21, this species is most closely related to *N. benthamiana*, from which it differs in its more woody stems, the rather fleshy nature of the foliage, the sessile cauline leaves, considerably larger flowers, reniform rather than oblong or trapezoid-reniform seeds, different chromosome number and different ecology.

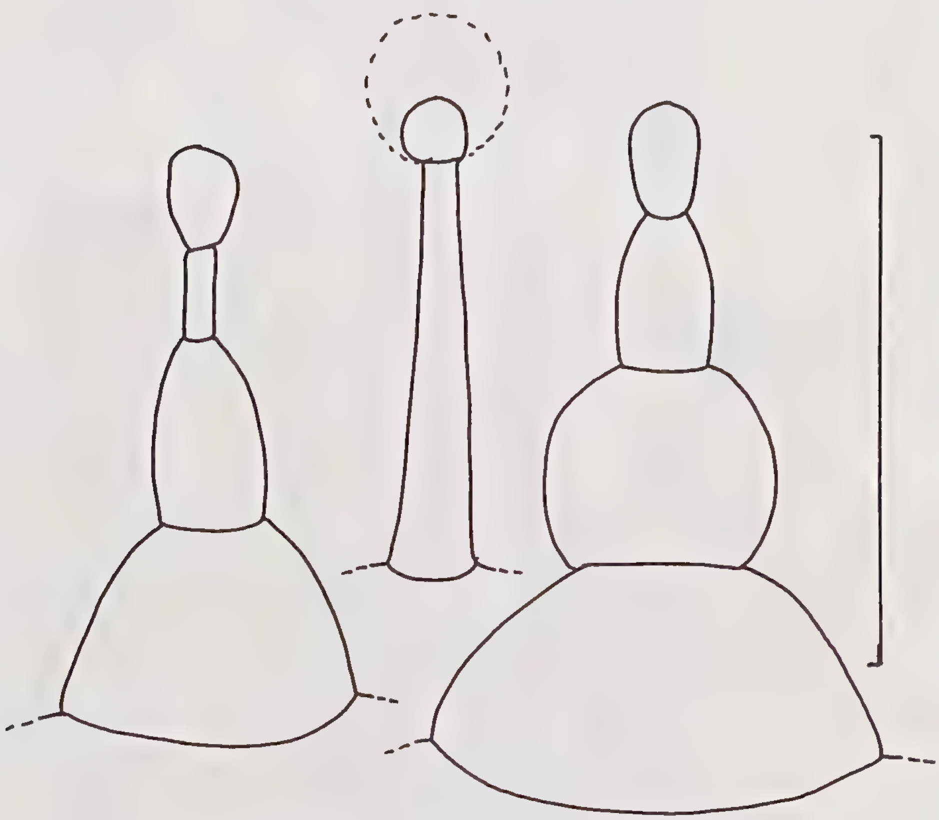


Fig. 3. Calyx hairs of *N. burbidgeae* (Scale = 0.25 mm)

From plants in cultivation, Mr R.D. Pearce reports a number of flowers in which the styles are not fully developed and style lengths between 2 cm and 7 cm have been noted. All of these flowers are fertile and set seed when pollinated. No explanation is available for this variability, but it may represent incipient cleistogamy common in some other Australian species of *Nicotiana*. The new species has a hair type not illustrated by either Burbidge or Horton. On the calyx and pedicel are hairs with a greatly enlarged basal cell which is almost hemispherical in shape and bears several swollen cells above it, Figure 3. The hairs most similar to these are illustrated by Burbidge (1960) (p. 376) for *N. simulans*. The swollen hairs are not as abundant as the simple glandular hairs, nor do they appear on the leaves, stem or corolla. After drying, the swollen hairs are not obvious on herbarium specimens and may therefore appear on some other species as well when fresh material is available. Another feature of plants in cultivation was the change in corolla tube length as the growing season changed from summer to winter. The summer flowers had tubes to 7-8 cm long while in winter the same plants produced flowers with tubes reduced to 4 cm. Plants collected in the field in June had tube length c. 4 cm while those collected in September had a tube length c. 5.5 cm. This character is apparently greatly influenced by environmental factors.

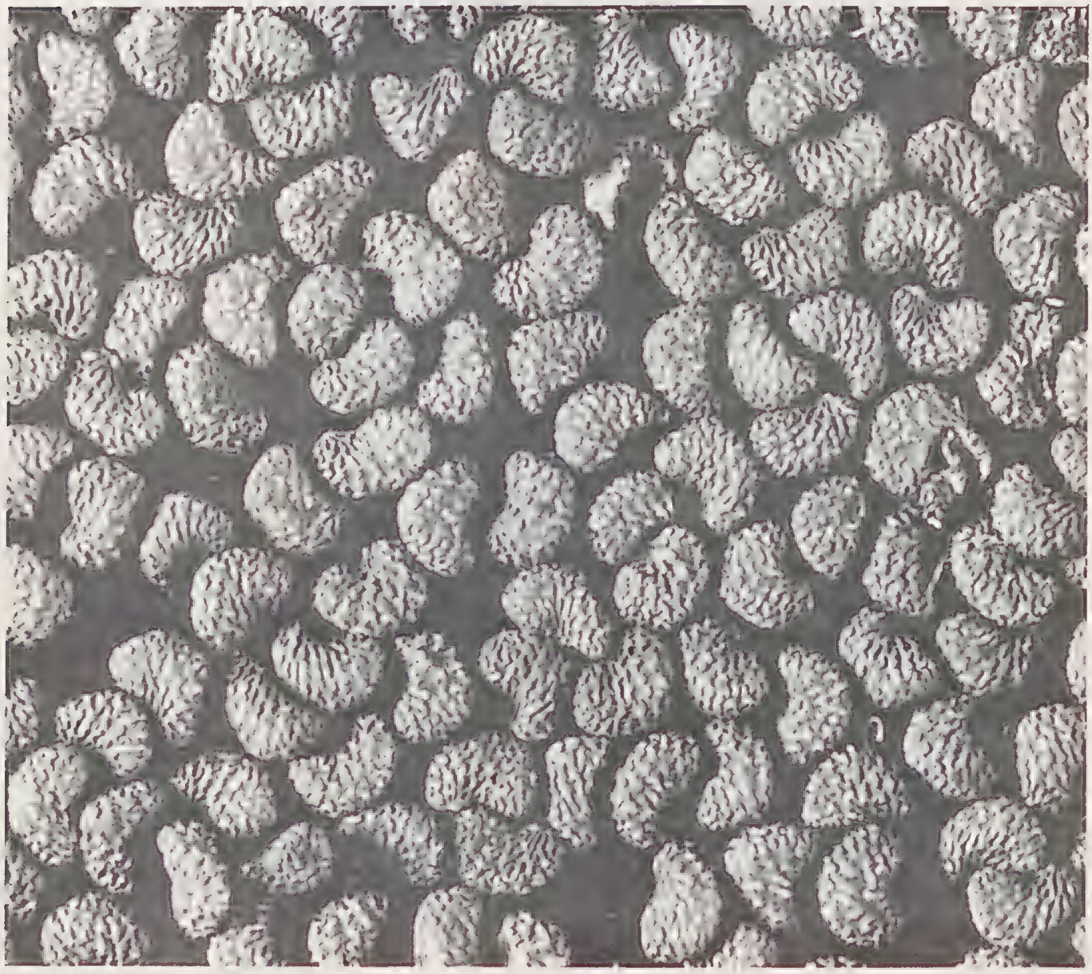


Fig. 4. Seeds of *N. burbidgeae*.

The species is named after Miss N.T. Burbidge for her contributions to taxonomic botany in Australia.

The species may be keyed out if the following addition is made to the key: Horton (1981) p. 10.

9. Flowering stems leafy; flowers interfoliar 9a

9. Flowering stems leafless above; flowers in racemes or panicles 10

9a. Calyx hairs not greatly swollen at base; corolla tube 25-55 mm long, corolla limb 10-20 mm diam., seeds oblong or trapezoid-reniform .... *N. benthamiana*

9a. Some calyx hairs with hemispherical basal cell; corolla tube 40-70 mm long, corolla limb to 50 mm diam., seeds reniform .... *N. burbidgeae*

The following addition to the Fl. Australia, George (1982) 44 will enable it to be keyed out there.

3: Ellipsoid-headed glandular hairs absent

7. Flowering stems leafy; flowers solitary in leaf axils or arising from internodes 7a

7a. Calyx hairs not greatly swollen at base; corolla tube 25-55 mm long, corolla limb 10-20 mm diam.; seeds oblong or trapezoid-reniform .... *N. benthamiana*

7a. Some calyx hairs with hemispherical basal cell; corolla tube 40-70- mm long, corolla limb to 50 mm diam.; seeds reniform .... *N. burbidgeae*

An apparently natural hybrid between *N. burbidgeae* and *N. velutina* was collected at the same time as the type of *N. burbidgeae* (*Symon 9306*, ADW 48346, Dupl. AD). This isolated plant was growing in a dry, sandy stream bed and the putative parents were in the vicinity. It is intermediate in its morphology and was obvious in the field because the corolla remained open at least in the morning, in contrast to *N. velutina*. The long flowering stems bore no capsules; Miss Horton *loc. cit.* has examined the pollen and only about 4% appeared normal.

Specimens seen

SOUTH AUSTRALIA: *Symon 9294*, 24.ix.1974, S.E. of Dalhousie Springs complex (type collection), (AD, ADW, CANB, L, MO, NT); *Symon 9354*, 26.ix.1974, S end of Dalhousie Springs complex (ADW, CANB, K); *Symon 9895*, ix.1974, S.E. of Dalhousie Springs, seedling collected in the field and grown at the Waite Agricultural Research Institute (ADW, CANB); *Symon 13123*, 22.vi.1983, banks of small creeklines (headwaters of Irrapowadna and Lowther Creek) 7 km before Dalhousie ruins and c. 40 km from Pedirka. Scattered plants to 50 cm, flowering freely (ADW, BRI, NSW, PERTH, US).

References

Burbidge, N.T. (1960). The Australian species of *Nicotiana* L. (Solanaceae). *Aust. J. Bot.* 8: 342-380.
George, A.S. (1982) Edit. "Flora of Australia" 29: 38-57. (Aust. Govt Publ. Serv.: Canberra).
Horton, P. (1981). A taxonomic revision of *Nicotiana* (Solanaceae) in Australia. *J. Adelaide Bot. Gard.* 3: 1-56.

J. Adelaide Bot. Gard. 7(1): 123-126 (1984)

A NEW FORM OF *SOLANUM* FRUIT

D.E. Symon

Agronomy Department, Waite Agricultural Research Institute,
Glen Osmond, South Australia 5064

Abstract

In two northern Australian species of *Solanum* the usual berry fruit has been modified to form a censer with wind ballist seed dispersal. The fruit structure and dispersal mechanism are described and compared with similar fruits in other groups.

Most texts describe the fruit of *Solanum* species as berries, "a pulpy fruit with immersed seeds". Variations on this form of fruit occur and several are mentioned in my paper Symon (1979) on fruit diversity and dispersal in *Solanum* in Australia. Brief mention was made there of an unnamed species from Kalumburu in the Kimberleys of Western Australia. The tall willowy plant was illustrated and later described as *S. tudununggae* (Symon 1981). The plant has been grown in cultivation and after hand pollination of the females a number of fruits were set. Figure 1 shows three fruits at maturity, the centre one with the calyx cut away to show the dried shrunken berry not yet separated; the left hand one shows the fruit circumscissile towards its base, released within the calyx tube from which it is not free to fall, but where it forms a loose plug. From the orifice of the calyx tube the seeds may then be shaken out. The free cap is broadly conical, thin and papery at the point of rupture, the apex relatively thick and firm. There is no indication of what process brings about the rupture, but it is probably the shrinkage of the cap with its solid apex relative to the base, which pulls the cap from its base on drying. The massively thickened apex of the berry tapers away to the point of abscission. A sketch of both longitudinal and transverse sections of a mature fruit are shown in Figure 2. The transverse section is typical of many *Solanum* fruits.

The berry is broadly adherent to the calyx at its base. No septum divides the berry when ripe, but a trace of the disintegrated septum is visible lining the cap. The placenta is deeply divided into two lobes the bases of which are several millimetres apart. The three fruits illustrated contained 172, 199 and 235 seeds, many of which are borne right at the base of the placenta and between the lobes so that they are well below the level of the rupture zone.

Since *S. tudununggae* was collected and grown, Mr K. Kenneally has re-collected *S. vansittartensis* first described by C.A. Gardner in 1923. Although very different in leaf form to *S. tudununggae* this species also has a similar slender growth habit and fruit. The fruits are a little larger than those of *S. tudununggae* but identical in basic structure. The calyx wall is somewhat tougher and certainly more prickly, the apex of the fruit after shedding also being rather thick and firmer. The fruit is illustrated in Figure 3.

The seeds of the two species are very similar being c. 2.5 mm long, subreniform, flattened, minutely reticulate and black. In both species the fruits are held close to the stem at an angle of about 45° on short, thick pedicels. This is a censer mechanism for seed dispersal and the tall willowy growth habit is effective in scattering the seeds in the vicinity of the plant. One imagines the mechanism operates best under gusty, windy conditions; a wind ballist method of seed dispersal.

Both of these species are restricted in distribution to the northern parts of the Kimberleys region on the Mitchell Plateau and the vicinity of Kalumburu. Both occur on areas of dissected sandstone tableland and both may be annuals or biennials, but their life

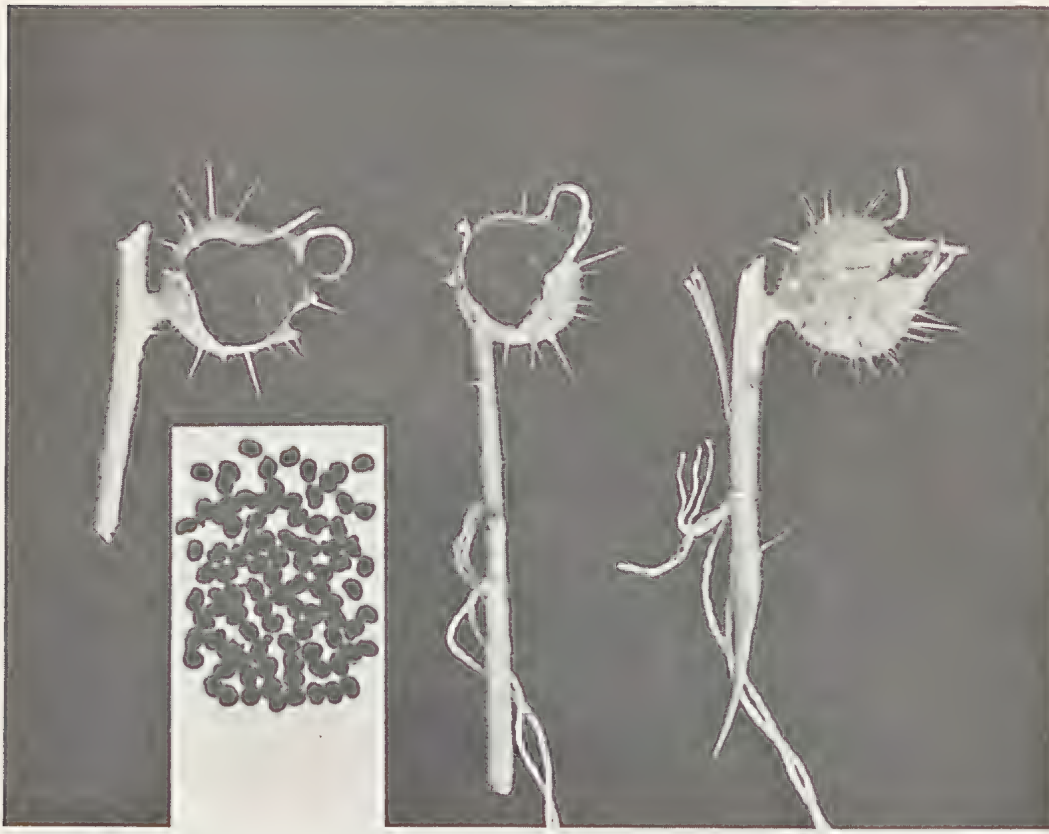


Fig. 1. Mature fruits of *S. tudununggae*. On left: calyx cut away to show loose cap within the calyx and some of the seeds; in the centre: calyx cut away to show the cap still attached; on the right: intact fruit.

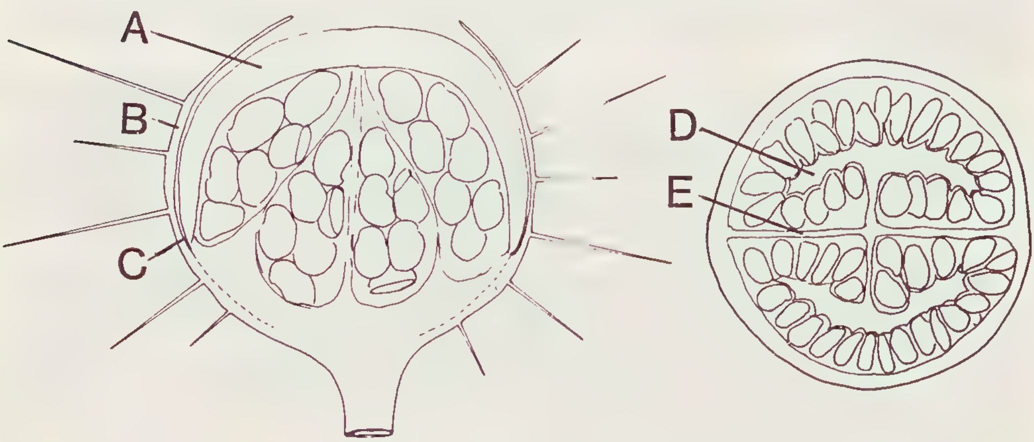


Fig. 2. Tangential longitudinal section and transverse section of fruits of *S. tudununggae*. A: thickened apex of the berry; B: enveloping calyx; C: zone of abscission; D: placenta; E: septum.

cycle is inadequately known. Both belong to the group of dioecious species which are almost restricted to the north west of Western Australia. Considering the small size of the group the range of fruit types is remarkable, see Table 1.

Table 1. Fruit type in dioecious species of *Solanum*

Species	**Fruit type**
S. asymmetriphyllum	succulent berry
S. dioicum	mucilagenous berry
S. cunninghamii	mucilagenous berry
S. carduiforme	berry
S. petraeum	bony-walled berry
S. leopoldensis	bony-walled berry
S. tudununggae	censer
S. vansittartensis	censer
S. cataphractum	unknown

Some species of *Solanum* with dry subcapsular fruits are known, e.g. Section Androceras. The most widespread species, *S. rostratum* Dunal (buffalo burr), has a berry tightly enclosed within the adherent, prickly calyx tube. At maturity, both the calyx tube and the now dry berry rupture to form a cup-like structure containing the dry seeds and their release is mediated by wind, rain or other movement (Whalen 1979). The plants are essentially short and sturdy and the seeds 'spilt' rather than shaken out. The structure of the berry and plant habit are radically different in the Australian species.

Before maturity, a berry and a capsule may not differ greatly in essential structure. The ripe berry is usually succulent with seeds immersed in moist flesh which rarely ruptures. In those cases where it does, e.g. *Momordica balsamina* L., the ruptures are irregular and the seeds are enveloped in red flesh and thus become available for dispersal. The fruit of *Datura inoxia* Mill. breaks irregularly, is somewhat mealy in character, and the seeds bear an elaiosome and are available for secondary dispersal.

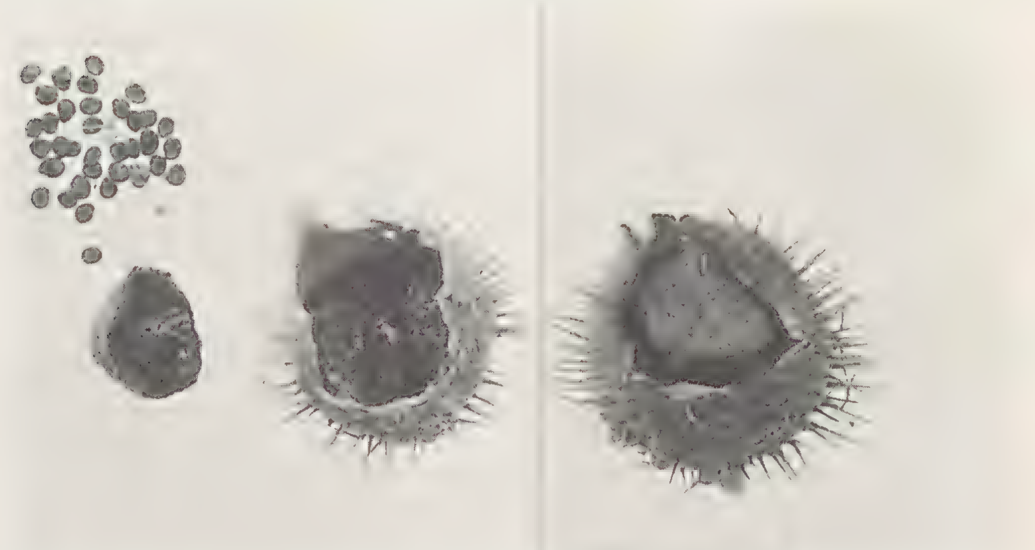


Fig. 3. Mature fruits of *S. vansittartensis*. On left: seeds and cap; in the centre: broken calyx showing dried placenta and zone of fracture; on the right: mature fruit with calyx cut away to show cap in position.

Capsules are dry at maturity and usually rupture along defined sutures, e.g. *Nicotiana* species; others have apical pores, e.g. *Papaver* species. In none of these is the calyx an essential part of the mechanism, though some capsules may be substantially enclosed in the calyx, e.g. *Nicotiana.* In capsules which split open the sutures are usually longitudinally oriented, e.g. most Scrophulariaceae. In the more specialised examples apical pores have developed, e.g. *Papaveraceae.* Circumscissile dehiscence is less common but may be seen in *Hyoscyamus niger* L. (hen bane) where a cap-like apex is shed and the seeds released. In this species the capsule is substantially protected by a spinescent calyx but the cap is not retained within the calyx. The mechanism of dispersal described for the two Australian species of *Solanum* would thus appear to be modification of a berry fruit not previously reported.

Acknowlegement

I am very grateful to Mr K.F. Kenneally of Western Australia Herbarium, Perth, for sending me mature fruits of *S. vansittartensis.*

References

Pijl, L. van der (1972). 'Principles of Dispersal in higher Plants'. (Springer Verlag: Berlin).
Symon, D.E. (1979). Fruit diversity and dispersal in *Solanum* in Australia. *J. Adelaide Bot. Gard.* 1: 321-331.
Symon, D.E. (1981). A revision of the genus *Solanum* in Australia. *J. Adelaide Bot. Gard.* 4: 1-367.
Whalen, M.D. (1979). Taxonomy of *Solanum* Section Androceras. *Gentes Herbarium* 11: 359-426.

J. Adelaide Bot. Gard. 7(1):127-134 (1984)

A CHECKLIST OF PLANTS OF DALHOUSIE SPRINGS AND THEIR IMMEDIATE ENVIRONS

D.E. Symon

Agronomy Department, Waite Agricultural Research Institute,
Glen Osmond, South Australia 5064

Abstract

Dalhousie Springs are the largest and most impressive of the artesian mound springs which are scattered along the western and southern margins of the Great Artesian Basin. A checklist of angiosperm plants is provided.

The nature and distribution of mound springs in South Australia have been described by Casperson (1979) and Harris (1981). Their presumed geological structure was described by Williams & Holmes (1978) and the analysis and flow of water from the Dalhousie Springs by Williams (1974), who states that all the waters are alkaline, the range in temperature is from 29 to 44°C, and they have salinities ranging from 650-2000 mg/l. The total flow from the whole area was estimated to be 0.86 cumecs. Dalhousie Springs are situated north-east of Oodnadatta at 26° 28′ Lat., 135° 29′ Long. in a valley in one of the most desolate areas of Australia. The mean annual rainfall is approximately 130 mm and evaporation approximately 3 m/yr. In the area are more than 70 discrete springs and the total area of vegetation maintained by the springs is 8.8 km^2, Williams & Holmes (1978).

The valley margin is bordered by break-away slopes leading up to desolate stony 'gibber' plains and the easternmost margin of the Springs is only 50 km from the western edges of the Simpson Desert. The approach to the valley of the Springs was graphically described by White (1914), "this patch [of land] is the most weird, the most woebegone, the most desolate, one can imagine. We had left the sandhill country earlier in the day and had then to cross rough upland gibber plains, broken here and there by bare flat-topped desert sandstone hills, then we descended into a depression and found the surface dotted over with strange dark coloured mounds out of which oozed from warm to hot water". Some of the plants collected by S.A. White on that expedition are still preserved in the State Herbarium.

The numerous springs in the group range from those with large clear pools and active water flow (up to 14.3 megalitres per day, Williams [1974]), while others trickle, seep or are moribund. The mounds vary in size from a few to 100 m in diameter generally with a shallow rounded profile and may be up to 10-12 m high. The valley floor has markedly saline areas due to the evaporation of the water and the lack of any flushing action by the very low annual average rainfall. The micro-habitats both close to the active springs and in the valley floor are numerous and range from warm-water aquatic sites with constant flow, through variously drained and exposed slopes to soils too salty to sustain vegetation.

The actual discovery of the Springs is described by Mr R.R. Knuckey, a contractor for a portion of the overland telegraph line and is published in Richards (1914). Since this publication is not readily available it is presented here. "At about 10 miles [from their camp] we found the soda flat and a small mound spring. About one mile north we came across another mound spring with reeds growing round it. I named the spring "Bee Spring" after Mr. Tom Bee, McMinns cadet. About 1½ miles from here we came on the main body of the springs. As far as the eye could reach to the east, the reeds showed the presence of the springs. To the north they were bounded by a low range of saddle-backed hills and to the westward the same range extended terminating in a point named Mount Crispe. The reeds where we struck the springs—(I measured one) were 17 feet high and as thick as your finger.

We could hear the gurgling among the reeds and as we had to camp there that night the horses had to be watered, so we cut down some reeds, made a corduroy road of them and led our horses to drink into as pretty a stream of water as a bushman could wish to see, about 3 feet wide, 18 inches deep, clear as crystal and fresh and sweet as mountain dew. We found the head of that spring. It was what we called a mud spring, that is the water (natural artesian wells) contained no sodium or magnesium, and therefore the overflow left no sediment.

Now before we left Adelaide, Lady Edith Ferguson, wife of Sir James Ferguson, the Governor of South Australia, had presented each of our parties with a box of books. These boxes contained all the standard novels of the day. Each box was different and there were 6 Bibles and 6 prayer books among them. Now we decided amongst ourselves that we would name the most important find after her and these springs came up to our expectations. They are the greatest area of springs in Australia. There is any kind of water you like in them, salt, magnesia, hot/cold and fresh and so that afternoon December 21, 1870, I christened them the Lady Edith Springs. As I was on the nearest section to Adelaide I sent in to our chief, Mr. Todd, the maps of the country as far as we had gone. Mr. Todd showed the map to Lady Edith, who wrote thanking us and asking us to change the name to her family name, Lady Edith was the daughter of the Marquis of Dalhousie, and that is how the Dalhousie was named."

The following people are known to have made some collections of plants at the Springs. S.A. White 1913, E.H. Ising 1932, W.S. Reid 1956, T.R.N. Lothian 1963, F. Mitchell 1968, T.J. Fatchen 1972, and P.K. Latz 1974, but as the specimens are now scattered through the herbarium collections they have not been included here. Those made by S.A. White were reported on by J.M. Black in White (1914b). My own collections were made in 1965, 1974, and 1983 and form the basis of the following account. They include species found in the immediate vicinity of the Springs and the associated saline flats, but not plants of the 'break away' slopes and gibber plains.

The plants closely associated with the springs and totally dependant on them for water are listed in Appendix I. Three trees dominate the spring vegetation. *Melaleuca glomerata* dominates the wet springs where it forms a large tree often with several trunks which may be 30 cm in diameter. The trunks are covered with copious pale paper-bark. The sprawling trunks and fallen trees show evidence of wind throw. *Myoporum acuminatum* is a small tree or large, bright green shrub which often surrounds the *Melaleuca* or is mixed with them. It is often abundant and occasionaly extends out on the 'tails' from the springs. *Acacia salicina* is a small, short lived tree often clonal in habit, and usually occupies the outer fringes and drier slopes of the low mounds. In some of the dry mounds, *A. salicina* may be the dominant tree. On the outer zones of the tree vegetation and on the upper slopes of the mounds may be found *Pimelea microcephala*, *Halosarcia* spp (samphires), *Enchylaena tomentosa* (ruby saltbush), and *Atriplex nummularia* (old man saltbush) and abundant *Sporobolus virginicus*.

Closely associated with free water are *Typha domingensis* (bulrush) and *Phragmites australis* (bamboo reed). On the mounds these combine with the *Melaleuca* and *Cyperus gymnocaulos* to form almost impenetrable thickets now much damaged by cattle, feral horses and donkeys forcing their way through, pugging the peaty ground and grazing the reeds. The bulrush and bamboo reed may extend from the centre of the mounds out to the distant tails, but do not occur on the drier phases. Occurring with these, but usually where more exposed and then extending to the drier phases of the tails, are extensive areas of *Cyperus gymnocaulos*. This tough species is less heavily grazed and the clumps may protect occasional plants of *Juncus kraussii*. The *Cyperus* also gives some protection to palatable plants such as *Sonchus* spp. (thistles) and *Senecio* affin. *cunninghamii* which are otherwise heavily grazed.

Fig. 1. *Typha* and *Phragmites* surrounding one of the largest free-water springs.

Fig. 2. General view of low mound showing the dense vegetation surrounding the large spring (out of sight). The farm implements were abandoned after efforts to use the spring for irrigation. Assorted halophytes in the foreground.

Within the mounds, close to water and sheltered by the preceding species the following may occur:-

Sonchus oleraceus	*Samolus repens*
S. hydrophilus	*Hydrocotyle verticillata*
Senecio affin. *cunninghamii*	*Polygonum salicifolium*

In open wet sites (but rarely in dense cover) occur:-

Cyperus laevigatus	*Baumea arthrophylla*
Bolboschoenus caldwellii	*Hydrocotyle verticillata*
Eleocharis pallens	*Lemna disperma*

The last five seem relatively rare and only few collections have been made.

Draining away from springs may be a long tail of vegetation as the water flows away, seeps through the ground and finally evaporates. The soils associated with these tails of vegetation become increasingly saline towards their ends and margins. Along the tails, but only associated with the free water phases, may be occasional *Melaleuca*, *Myoporum* together with *Typha* and *Phragmites*. In wet open areas may occur *Cyperus laevigatus*, (very common), *Bolboschoenus caldwellii* (very palatable). The drier phases with no free water are covered mainly by *Cyperus gymnocaulos* with occasional *Frankenia pauciflora*.

Very few aliens have become established. *Phoenix dactylifera* (dates) must be considered adventive if not naturalised as young plants now occur well away from the original planted palms at the Dalhousie ruins. In addition *Cyperus laevigatus* and *Polypogon monspeliensis* are considered introductions to the South Australian flora.

Fig. 3. *Frankenia muscosa* a compact hummock forming species on highly saline ground.

In the general vicinity of the springs the flats and dry lower slopes are dominated by *Halosarcia pluriflora*, *Sclerostegia tenuis* (samphires), *Nitraria billardieri* (nitre bush) and *Selenothamnus squamatus* with occasional plants of *Eremophila longifolia*, *E. duttonii*, *Acacia victoriae*, *Pittosporum phyllireaoides*,*Atriplex nummularia*, *Scaevola spinescens*, *Frankenia muscosa* and the small sub-shrubby chenopods *Enchylaena*, *Maireana* and *Sclerolaena*. Due to heavy rabbit grazing the smaller herbaceous plants are now rare, but the following have been collected: *Babbagia*, *Eragrostis*, *Enneapogon*, *Lawrencia*, *Pluchea*, *Sclerolaena*, *Pterocaulon* and *Zygophyllum*. The exclosures maintained by B.G. Lay of the South Australian Department of Agriculture have shown that the rabbits have a major effect on the persistence and regeneration of the herbaceous plants of the area (personal communication) in addition to the grazing and physical damage by the larger animals.

Plants associated with the saline flats are listed in Appendix II. The saline flats have resulted from the evaporation of the spring water and their plants have wider distributions, being found extensively in arid South Australia in similar ecological sites.

Approximately 60 km east of the Dalhousie Springs complex is Purnie Bore. This bore was put down during a period of oil exploration and has been flowing since 1964. The water forms a large lagoon several hundred metres long between the sand dunes. Regrettably since then this portion of the desert has been stocked with cattle.

Fig. 4. Regeneration of *Sporobolus virginicus* after 21 months protection from rabbits and stock. Photo per B. Lay.

In 1974, ten years after it was established, the following semi-aquatic plants were collected:

Chara	Symon 9400
Cyperus gymnocaulos Steudel	Symon 9395
* *Cyperus laevigatus* L.	Symon 9397
* *Heliotropium curassavicum* L.	Symon 9398
* *Parapholis incurva* (L.) C.E. Hubb.	Symon 9399
Schoenoplectus litoralis (Schrader) Palla	Symon 9396
Typha domingensis (Pers.) Steudel	Symon 9394

On my most recent visit to this bore (June 1983), only the two species of *Cyperus* and *Typha* were evident. The area is heavily stocked and plants along the edge of the water are under severe grazing pressure. It is noticeable that none of the woody plants associated with Dalhousie Springs have become established. Conversely neither *Parapholis* nor *Schoenoplectus* have been detected at Dalhousie Springs yet. The two species of *Cyperus* and *Typha* now occur about almost all bores and springs in Central Australia where free water is available, and obviously have efficient methods of seed dispersal.

Conservation

The interesting geological origins of the springs and their unique place in the arid landscape justify their protection.

The fish fauna alone (not dealt with here) supports the claim as no fewer than six species occur there, one of which is confined to these springs, Glover & Sims (1978).

The importance of the free water for birds and local animals is obvious by their numbers. At least one thousand tree martins were seen hawking over one of the larger pools.

More thorough botanical sampling of the many sites will undoubtedly reveal species not yet collected. In the times and conditions available to me it has not been possible to visit all of the Springs. Nor was Williams (1974) information on water flow available when the first visits were made which could have assisted in selecting sites. From the collections made to date the following are noteworthy:-

Baumera arthrophylla, only record for northern South Australia.
Hydrocotyle verticillata, only record for northern South Australia.
Isolepis hookerana, new record for Central Australia.
Polygonum salicifolia, only record for northern South Australia.
Lemna disperma, a new record for Central Australia.
Goodenia anfracta)
Haloscarcia fontinalis)
Maireana luehmannii) These are all uncommon plants in South Australia.
Sclerolaena clelandii)
Zygophyllum crassissimum)
Nicotiana burbidgeae, a new species solely confined to the south-western end of the Springs complex.

Because of the permanent water and associated plant growth, this area suffers severe grazing pressure from cattle and horses, as well as feral rabbits and donkeys. Fencing off at least some of these springs and eradication of animals within these areas may well reveal new plant species, at present suppressed beyond recognition. The uniqueness of this whole complex of springs and associated landforms, quite apart from their intrinsic botanical interest, makes it essential they be given some form of protection. Vegetation damage caused by indiscriminate use of off-road vehicles has also increased alarmingly during the period of study. It would be a tragedy if this complex suffers the same fate as many of the mound springs further north—now totally devastated by uncontrolled animal use (Harris 1981).

Acknowlegements

I would like to thank Mr G.W. Krieg of the South Australian Department of Mines for transport and assistance to Dalhousie Springs in 1974 and Mr B.G. Lay, South Australian Department of Agriculture for the same in 1983.

References

Casperson, K. (1979). Mound springs of South Australia. Projects Section S. Aust. Dept. for the Envir. 23 pp.

Glover, C.J.M. & Sim, T.C. (1978). Studies on Central Australian Fishes: a progress report. *S. Aust. Naturalist* 52: 35-44.

Harris C. (1981). Oases in the desert: the mound springs of northern South Australia. *Proc. Roy. Geogr. Soc. Aust. (S.A. Branch)* 81: 26-39.

Richards, J.B. (1914). The overland telegraph line: its early history. W.K. Thomas & Co.: Adelaide.

White, S.A. (1914a). Into the dead heart: an ornithological trip through Central Australia (pp. 41-50). W.K. Thomas & Co.: Adelaide.

White, S.A. (1914b). Scientific notes on an expedition into the interior of Australia carried out by Captain S.A. White, M.B. O.U. from July to October 1913. *Trans. Roy. Soc. S. Aust.* 38: 407-474.

Williams, A.F. (1974). Sampling and measurement of the Great Artesian Basin mound springs. Progress Report No. 1, Dalhousie Springs. S. Aust. Dept. Mines unpublished report 74/204.

Williams, A.F. & Holmes, J.W. (1978). A novel method of estimating the discharge of water from mound springs of the Great Artesian Basin, Central Australia. *J. Hydrol.* 38: 263-272.

Appendix I

Plants closely associated with the Springs

Acacia salicina Lindley. Abundant, *Symon 3242, 3246, 9342, 13126, 13148.*
Amyema preissii (Miq.) Tieghem (on *Acacia*), *Symon 3245, 13161.*
Baumea arthrophylla (Nees) Boeckeler. Rare, *Symon 9331.*
Bolboschoenus caldwellii (V. Cook) Sojak. Occasional, *Symon 13158, 13170.*
Chara sp. *Symon 13168.*
Cyperus gymnocaulos Steud. Abundant, *Symon 3258, 9336, 13131, 13154.*
**Cyperus laevigatus* L. Abundant, *Symon 3248, 9337, 13130, 13169.*
Eleocharis ? pallens (Benth.) Blake. Rare, *Symon 3253, 9330, 13166.*
Enchylaena tomentosa R. Br. Abundant, *Symon 9308, 9311, 13124, 13142.*
Fimbristylis ferruginea (L.) Vahl. Rare, *Symon 3244, 13167.*
Frankenia pauciflora DC. Occasional, *Symon 3252, 9301, 9339, 13165.*
Frankenia muscosa Abundant, see App. II.
Hemichroa diandra R. Br. *Symon 9341.*
Hydrocotyle ? verticillata Thunb. Rare, *Symon 13162.*
Imperata cylindrica (L.) Beauv. Abundant, *Symon 3247, 9333, 13132, 13157.*
**Isolepis hookerana* Boeck. Uncommon, *Symon 13162A.*
Juncus kraussii Hochst. Occasional, *Symon 3256, 9335, 13156.*
Lemna disperma Hegelm. Rare, *Symon 13212.*
Melaleuca glomerata F. Muell. Abundant, *Symon 3259, 9307, 9359, 13134.*
Myoporum acuminatum R. Br. Abundant, *Symon 3241, 9310, 13127, 13146.*
**Phoenix dactylifera* L. Occasional, *Symon 3243, 9329, 13173.*
Phragmites australis (Cav.) Trin. ex Steudel. Abundant, *Symon 3255, 9334, 13133, 13172.*
Pimelea microcephala R. Br. Common, *Symon 9309, 13125.*
Polygonum salicifolium Brouss. ex Willd., Rare, *Symon 13129.*
**Polypogon monspeliensis* (L.) Desf., *Symon 9338.*
Samolus repens (Forst. et Forst. f.) Pers. Rare, *Symon 9327.*
Senecio affin. *cunninghamii* DC., Rare, *Symon 13160.*
Sonchus oleraceus L. Common, *Symon 13220.*
Sonchus hydrophilus Boulos, Occasional, *Symon 9328, 13159.*
Sporobolus virginicus (L.) Kunth., Abundant, *Symon 3249, 9344, 13137.*
Typha domingensis (Pers.) Steudel, Abundant, *Symon 3257, 13171.*

*The asterisk indicates introduced plants.

Appendix II

Plants on dry slopes of mounds or associated saline flats

Acacia victoriae Benth. Occasional, *Symon 9325, 13153.*
Atriplex nummularia Lindley. Common, *Symon 9317, 13179.*
Babbagia dipterocarpa F. Muell. Common, *Symon 9319, 13145.*
Centaurium spicatum (L.) Fritsch. Occasional, *Symon 3267.*
**Citrullus colocynthis* (L.) Schrader. Occasional, *Symon 13164.*
Cressa cretica L. Occasional, *Symon 3266, 9363.*
Enneapogon cylindricus N. Burb., *Symon 13141.*
Eragrostis dielsii Pilger. Common, *Symon 13136.*
" *falcata* (Gaudich.) Benth. Common, *Symon 13135.*
Eremophila duttonii F. Muell. Rare, *Symon 9322.*
" *longifolia* (R. Br.) F. Muell. Rare, *Symon 13178.*
Eucalyptus microtheca F. Muell. Rare, *Symon 3273.*
Frankenia muscosa J.M. Black. Common, *Symon 3250, 9315, 13175.*
Goodenia anfracta J.M. Black. Occasional, *Symon 9349, 13188, 13206.*
Gunniopsis papillata Chinnock. Rare, *Symon 9345.*
Halosarcia fontinalis P.G. Wilson. *Symon 9302.*
" *halocnemoides* ssp. *longispicata* P.G. Wilson. *S.A. White 117.*
" *indica* var. *leiostachya* (Benth.) P.G. Wilson. *Symon 9303.*
" *pluriflora* P.G. Wilson. *Symon 3254, 9312.*
" *undulata* P.G. Wilson. *Latz 4795.*
Heliotropium curassavicum L. Occasional, *Symon 3269.*
Hemichroa diandra R. Br. Occasional, *Symon 3272, 9341.*
Lawrencia glomerata Hook. Common, *Symon 3268, 9318, 13138.*
Maireana appressa (F. Muell.) P.G. Wilson. Occasional, *Symon 9347.*
" *luehmannii* (F. Muell.) P.G. Wilson. *Symon 3271, 9346, 13204.*
" *pentatropis* (Tate) P.G. Wilson. Common, *Symon 9313, 13147, 13152.*
Minuria cunninghamii (DC) Benth. *Symon 9291.*
Nitraria billardieri DC. Abundant, *Symon 9292, 9314, 13155.*
Pittosporum phylliraeoides DC. Rare, *Symon 9350.*
Pluchea rubelliflora (F. Muell.) Robinson. *Symon 9340.*
Pterigeron cylindriceps J.M. Black. *Symon 9290.*
Pterocaulon sphacelatum (Labill.) Benth. *Symon 13139.*
Scaevola collaris F. Muell. Common, *Symon 3270, 9326, 13189.*
" *spinescens* R. Br. Occasional, *Symon 9324.*
Sclerolaena diacantha (Nees) F. Muell. *Symon 9316.*
" *clelandii* (Ising) A.J. Scott. *Symon 13144A.*
" *constricta* (Ising) A.J. Scott. *Symon 13143, 13205.*
" *lanicuspis* (F. Muell.) Benth. *Symon 13144B, 13203.*
Sclerostegia tenuis (Benth.) P.G. Wilson. *Symon 9304, 9320, 13151.*
Selenothamnus squamatus (Nees) Melville. Occasional, *Symon 3251, 9343.*
Trianthema triquetra Willd. Localised on rock heap, *Symon 13176.*
Zygophyllum compressum J.M. Black. Occasional, *Symon 9321, 9348.*
" *crassissimum* Ising. Rare, *Symon 3274, 13207.*
" *ammophilum* F. Muell. Common, *Symon 13163, 13177.*

*The asterisk indicates introduced plants.

J. Adelaide Bot. Gard. 7(1): 135-136 (1984)

NOTES ON THE SOUTH AUSTRALIAN FLORA

Monopsis simplex (L.) E. Wimmer (Campanulaceae), a new generic record for South Australia

Since 1962 when Miss D. Hunt sent material from damp or swampy sites in the Comaum area, near Naracoorte, a member of the subfamily Lobelioideae in Campanulaceae has caused problems in identification. It was initially identified in AD with *Lobelia rhombifolia* De Vriese, then *Lobelia pratioides* Benth. and most recently *Pratia purpurascens* (L.) E. Wimmer. In late 1983 it was found on Kangaroo Island (*G. Jackson 1636*).

The plant is *Monopsis simplex* (L.) E. Wimmer, a native of South Africa. It is a decumbent to erect, low annual with the flowers and especially the fruits abruptly upturned from the apex of the long pedicels. Material in AD matches closely with specimens from South Africa, New South Wales and Western Australia as well as a microfiche of its type in LINN, and corresponds closely with its description and illustrations in Wimmer's (1943-53) monograph of the subfamily.

Monopsis simplex is recorded as adventive in Australia from New South Wales (Beadle et al. 1963, 1982; presumably also Mueller 1876, Woolls 1891, as *Lobelia debilis* L.f.), Western Australia (Gardner 1930, as *Monopsis debilis*; Grieve & Blackall 1975; Green 1981), and from the southwestern districts of Victoria (Beauglehole 1980). The Victorian populations probably have a common origin with the southeast South Australian populations and these, like the separate Kangaroo Island introduction, are more likely to have originated from elsewhere in Australia than from a separate further introduction from South Africa; the species has been known for over a century in New South Wales.

The generic characteristics of the plant have been misconstrued by various workers, as has been independently discovered by Dr J.H. Willis, from his annotations of material in MEL. The plant's capsular fruit, dehiscing apically, and axillary flowers with corollas split on the adaxial side place it close to *Lobelia*. Indeed, only one reliable, but relatively obscure, generic character separates the two genera (Wimmer 1943-53). *Monopsis* has two greatly revolute narrow-linear stigmatic lobes ('filiform' according to Wimmer, but not in our material), while the two stigmatic lobes in *Lobelia* are short and more or less rotund. Alternative characters used by Grieve & Blackall (1975) and Beadle et al. (1963, 1982) do not work in this State. The former work distinguished *Monopsis* on its almost equal corolla lobes from the Western Australian *Lobelia* species with lower lobes much longer than the upper ones; in eastern Australia, however, *Lobelia pratioides* Benth. has almost equal corolla lobes. In the latter work *Monopsis simplex* was attributed red corollas and *Lobelia* white to purple, but annotations on the South Australian material of *Monopsis* refer several times to purple or deep purple corollas and only once to a "reddish purple" colour. South African specimens are annotated "purplish violet with darker centre" and "a deep violet blue . . .", while Wimmer (1957) describes it as "obscure violacea vel purpureo-coeruleo".

By its almost equal corolla lobes and linear to narrow-oblanceolate, sparingly denticulate leaves, *Monopsis simplex* superficially approaches most closely *Lobelia pratioides*. This species occurs in the same region but differs by its prostrate, stoloniferous perennial habit, narrow corolla lobes and upper anthers shortly ciliate on their distal margin. *simplex* is a decumbent to erect annual, not rooting at nodes, and has short, broad corolla lobes, and upper anthers shortly ciliate on their distal margin.

Specimens examined (chronologically arranged)

SOUTH AUSTRALIA, South-eastern region: *D. Hunt 1396*, 11.xi.1962, Hundred of Comaum, AD.—*D. Hunt 2243*, 15.xi.1964, Old Penola-Comaum track, AD.—*D. Hunt 2598*, 2.xii.1965, Penola Pine Forest Reserve, AD.—*K.M. Alcock 176*, x-xi.1968, Comaum, AD.—*K. Alcock s.n.*, s. dat. [prior to 1975], Comaum ca. 20 km E of Penola, AD97503127.—*K. Alcock 21*, iii.1976, Comaum, AD.—*R. Bates 4013*, 30.x.1977, near Mt Burr, AD. Kangaroo Island region: *G. Jackson 1636*, 11.xii.1983, Parndana golf course, AD.

NEW SOUTH WALES: *E. Betche 145*, 1882, Port Jackson, MEL.—*J.B. Cleland s.n.*, ix.1910, South Head, Sydney, AD97603097.

VICTORIA: *A.C. Beauglehole 37938*, 23.xi.1971, 5 miles W of Dergholm Post Office, MEL.—*A.C. Beauglehole 37962*, 26.xi.1971, 9¼ miles NW of Dergholm Post Office, MEL.—*A.C. Beauglehole & J.H. Willis s.n.*, 10.i.1972, about 11 miles SW of Casterton, in swamp ± 1½ miles NW of old Wilkin School, MEL574469.

WESTERN AUSTRALIA: *J.H. Willis s.n.*, 2.xii.1950, Bow's farm, about 10 miles NNE of Esperance, MEL584833.—*T.A. Halliday 214*, 5.xii.1974, 7 km W of Coodernup, on Rivervale road, AD.

SOUTH AFRICA: *Anon, s.n.*, s. dat., without locality, LINN 1051.1 (microfiche, AD: holotype of *Lobelia simplex* L., the basionym).—*W.F. Purcell 353*, 30.x.1915, Bergvliet Farm, Constantia, SAM.—*W.F. Purcell s.n.*, 20.xi.1918, Bergvliet Farm, Constantia, Lategan's vlei, SAM 90312.—*G.J. Lewis 1521*, xi.1944, Elgin, SAM.

References

Beadle, N.C.W., Evans, O.D., Carolin, R.C. & Tindale, M.D. (1963). "Handbook of the Vascular Plants of the Sydney District and Blue Mountains". (Armidale).

Beadle, N.C.W., Evans, O.D., Carolin, R.C. & Tindale, M.D. (1982). "Flora of the Sydney Region". 3rd Edn. (Reed: Frenchs Forest, New South Wales).

Beauglehole, A.C. (1980). "Victorian Vascular Plant Checklists—13—Study Area and 24—Grid Distribution". (Western Victorian Field Naturalists Clubs Association: Portland).

Green, J.W. (1981). "Census of the Vascular Plants of Western Australia". (Western Australian Herbarium: Perth).

Grieve, B.J. & Blackall, W.E. (1975). "How to Know Western Australian Wildflowers". Part 4. (University of Western Australia Press: Nedlands).

Mueller, F. (1876). *Lobelia debilis. Fragm. Phytograph. Australiae* 10: 43.

Wimmer, F.E. (1943-53). Campanulaceae-Lobelioideae. *Das Pflanzenreich IV.* 276b.

Woolls, W. (1891). "Plants Indigenous and Naturalised in the Neighbourhood of Sydney". (Govt Printer: Sydney).

W.R. Barker,
State Herbarium, Botanic Gardens,
Adelaide.

J. Adelaide Bot. Gard. 7(1): 137-144 (1984)

Plant Portraits

When this series was started in 1977 the editors had already envisaged allowing space 'to provide records in cases where taxa may be threatened with extinction', but this was never followed up. Many of the rarer plants have not been figured because of their rarity and because they often have only small and unobtrusive flowers. In presenting here a whole series devoted to endemic, rare and endangered plants of South Australia they will not only be illustrated but the text will provide a much needed forum to publish the present knowledge of these species in a readily accessible form at a time when conservation is in the minds not only of professional biologists.

10. Beyeria subtecta J. Black (Euphorbiaceae)

Beyeria subtecta J. Black, Fl. S. Austral. (1924) 357.

Illustration: A-L, based on fresh material preserved under *R. Davies s.n.*, late Oct. 1983, American River, Kangaroo Island (AD 98347163); M, based on a herbarium specimen *R. Davies & W. Bushman 16*, 22.x.1983, 600 m NNE of 6-road intersection, 12.5 km SE of Cygnet River township on Kingscote to Penneshaw road (AD).

Dioecious, viscid bush to c. 60 cm high; branchlets ascending, slender, terete, with lines of white tomentum, if present, usually obscured by viscid covering, with short leafy shoots in most axils. *Leaves* ascending, petiole c. 0.5-1 mm long, lamina linear, (3) 5-8 (10) x 0.8-1.2 (1.6) mm, entire, shortly mucronate, upper surface dark green, glabrous, with margin recurved, lower surface with narrow band of white appressed tomentum on either side of glabrous midrib. *Flowers* solitary, on short shoots; *male flowers* on slender pedicels (1.2) 1.5-3 (4) mm long, white-pubescent, tepals (4) 5, imbricate in bud, spreading, ovate, unequal, 1-1.8 mm long, light green to yellow or white, reddened in parts, pubescent at base, disc narrow, obscure *in vivo*, anthers (13) 15-22 (28), 0.35-0.5 x 0.35-0.45 mm, longer than or as long as broad, with 2 parallel cells on undivided connective; *female flowers* subsessile, white-pubescent, pedicel 0-0.6 mm long, tepals 5, erect, ± imbricate, ovate, 1-1.5 (2) mm long, enclosing ovary apart from the stigmas, carpels 2, ovules 1 in each cell, stigmas 2 broad recurved flaps forming a 2-lobed cap appressed to ovary. *Fruit* borne in persistent tepals on angular attenuate pedicel 0.2-1.3 mm long, c. 0.8-1 mm broad at apex, an obliquely broad-ovoid capsule, 3-3.5 x 2.1-2.8 mm, glabrous, dark green, with persistent black stigmatic cap 0.4-0.5 mm high, 0.8-1 mm wide, with only one carpel developing seed; seed broad-ellipsoid, 2.7-3.2 (3.5) x 2-2.2 (2.5) mm, shiny, grey, dark brown, or black- and grey-mottled, topped by a sessile hemispherical brown-yellow caruncle.

Until a series of samples from different plants within a range of populations was kindly collected by Mr R. Davies and Mr W. Bushman in the course of their studies of endangered species on Kangaroo Island (*Davies & Bushman 2-11, 15-19, 20 p.p., 21, 24 p.p., 25*, housed in AD, duplicates to be distributed), female and fruiting material of *Beyeria subtecta* had been unknown. From the three specimens available that were attributable to this Kangaroo Island endemic, all male-flowered (the type from 'Cygnet River' in the J.M. Black Herbarium and collections *J.B. Cleland AD 96826376* and *M.E. Phillips 776*), I doubted the worthiness of its separation from the variable and widespread *B. lechenaultii* (DC.) Baillon which also occurs on the Island. In these specimens Black's (1924, 1948) diagnostic characters of leaf mid-rib and indumentum and anther size break down and the leaf dimensions of the two species approach each other closely. It seemed likely that *B. subtecta* was but a small-leaved island variant of *B. lechenaultii*.

The female flowers and fruits, however, furnish valuable diagnostic characters, being subsessile in *B. subtecta* and distinctly pedicellate in *B. lechenaultii*. Furthermore, *B. subtecta* is remarkable for its ovary and fruit structure. The normal condition in the genus,

seen in *B. lechenaultii*, is an ovary of 3 carpels, each with a broad stigma and a single ovule capable of developing into a seed in the globular fruit. In *B. subtecta* there are only 2 carpels, each with its own ovule and stigma; only one of the ovules develops into a seed, giving the fruit an obliquely ovoid shape.

Mr Davies reports that *B. subtecta* is so restricted in its occurrence that its very survival is threatened. The species is confined to a region of a few square kilometres west of American River between Mt Thisby and Dead Horse Lagoon in *Eucalyptus cneorifolia-Melaleuca uncinata* association on acid lateritic sandy soils. Apart from a few impoverished populations on roadsides or on the very margins of regenerating vegetation, it is known from only two viable populations in well-regenerating sites. In comparison, *B. lechenaultii* is widespread on the Island in a variety of vegetation types and often on calcareous soils, but it does not occur in the specialised habitat occupied by *B. subtecta*. The degree of threat to *B. subtecta* is almost identical to *Grevillea muricata* J. Black, which is confined to the same small region.

By its anther cells adjacent and borne on an entire filament, *B. subtecta* belongs in Sect. *Beyeria*, in the sense of Bentham (1873), and shares with *B. lechenaultii*, its obviously closest relative, revolute leaves with a mat of white hairs on the underside between the midrib and margin. There is a parallel reduction to single-seeded fruits in the two Western Australian species *B. brevifolia* Baill. and *B. similis* Baill., but these have been placed in Sect. *Beyeriopsis* (Bentham 1873) on the basis of their bifid filaments (see Blackall & Grieve 1954). Both these species differ also by being monoecious and having pedicellate female flowers; furthermore the fruits of *B. similis* are 2-horned.

Distinctions of *B. subtecta* from its closest relative *B. lechenaultii*, with which it can occur sympatrically, can be summarised in the following key.

1a. Branchlets with viscid angles and lines of white pubescence between. Leaves (5) 8-22 or more x 1.0-4.5 (7) mm. Female flowers on pedicels 1.2-1.5 mm long, carpels 3, stigmas 3. Fruits globular with 3 1-seeded carpels, on pedicels 1.2-3 mm wide at apex; caruncle more than half diameter of seed .... *B. lechenaultii*

1b. Branchlets ± terete, viscid all around, with pubescence, if any, usually obscured. Leaves (3) 5-8 (10) x 0.8-1.2 (1.6) mm. Female flowers on pedicels 0-0.6 mm long, carpels 2, stigmas 2. Fruits obliquely broad-ovoid with a 1-seeded carpel and another smaller with an undeveloped ovule, on pedicels 0.8-1 mm wide at apex; caruncle less than half diameter of seed .... *B. subtecta*

References

Bentham, G. (1873). Euphorbiaceae. *Fl. Australiensis* 6: 41-153.

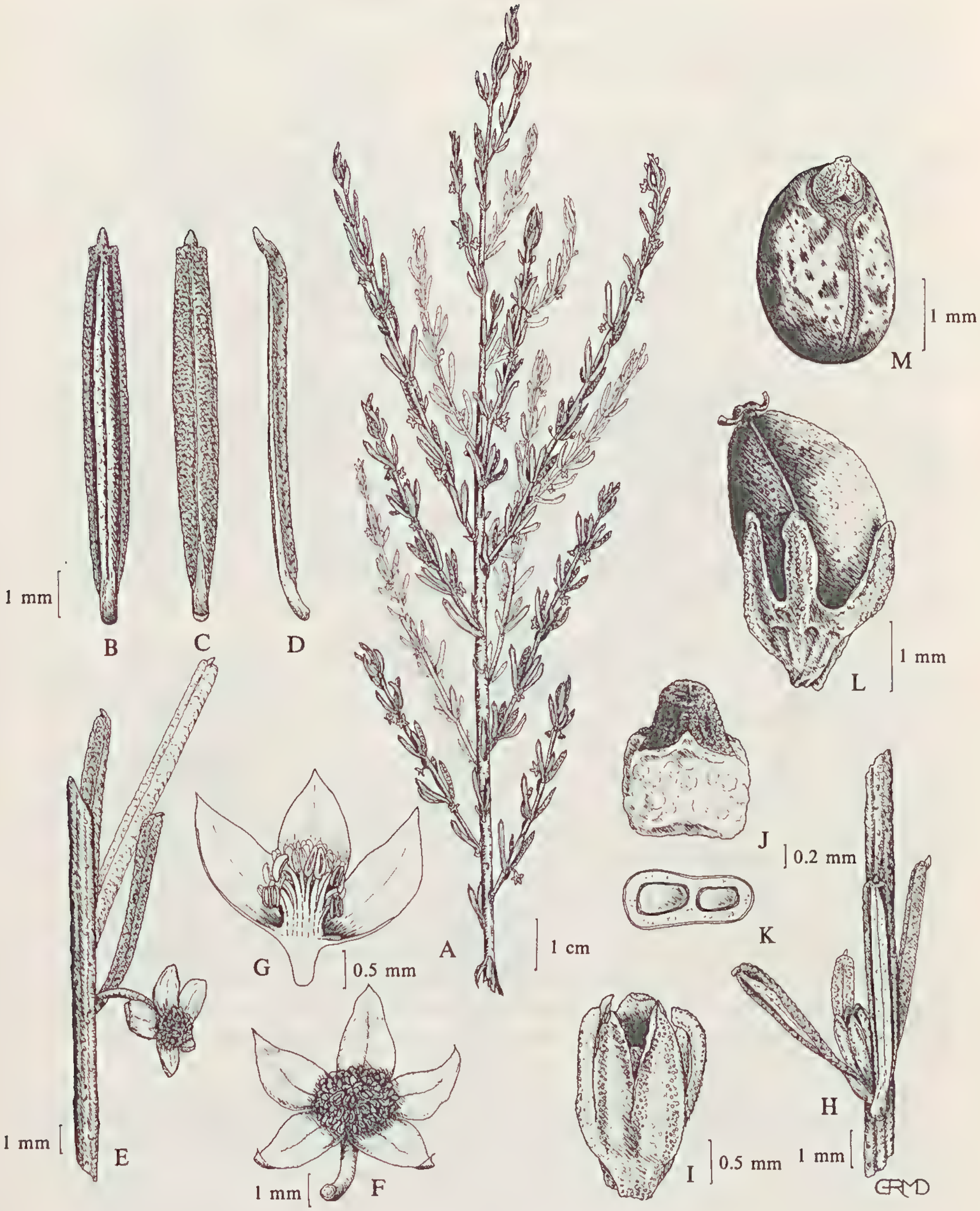
Black, J.M. (1924). Euphorbiaceae. In "Flora of South Australia", 1st edn. (Govt Printer: Adelaide), 348-358.

Black, J.M. (1948). Euphorbiaceae. In "Flora of South Australia", 2nd edn. (Govt Printer: Adelaide), 505-517.

Blackall, W.E. & Grieve, B.J. (1954). Euphorbiaceae. In "How to Know Western Australian Wildflowers". (Univ. of W. Aust. Press), 261-267.

W.R. Barker
State Herbarium of South Australia

Del. G.R.M. Dashorst
State Herbarium of South Australia



Beyeria subtecta J. Black. A, habit; B-D, leaf in lower, upper and side views; E, F, male flowers; G, male flower in longitudinal section; H, I, female flower; J, ovary; K, ovary in transverse section; L, fruit; M, seed.

11. Grevillea quinquenervis J. Black (Proteaceae)

Grevillea quinquenervis J. Black, *Trans. Proc. Rep. R. Soc. S. Austral.* 33 (1909) 225.

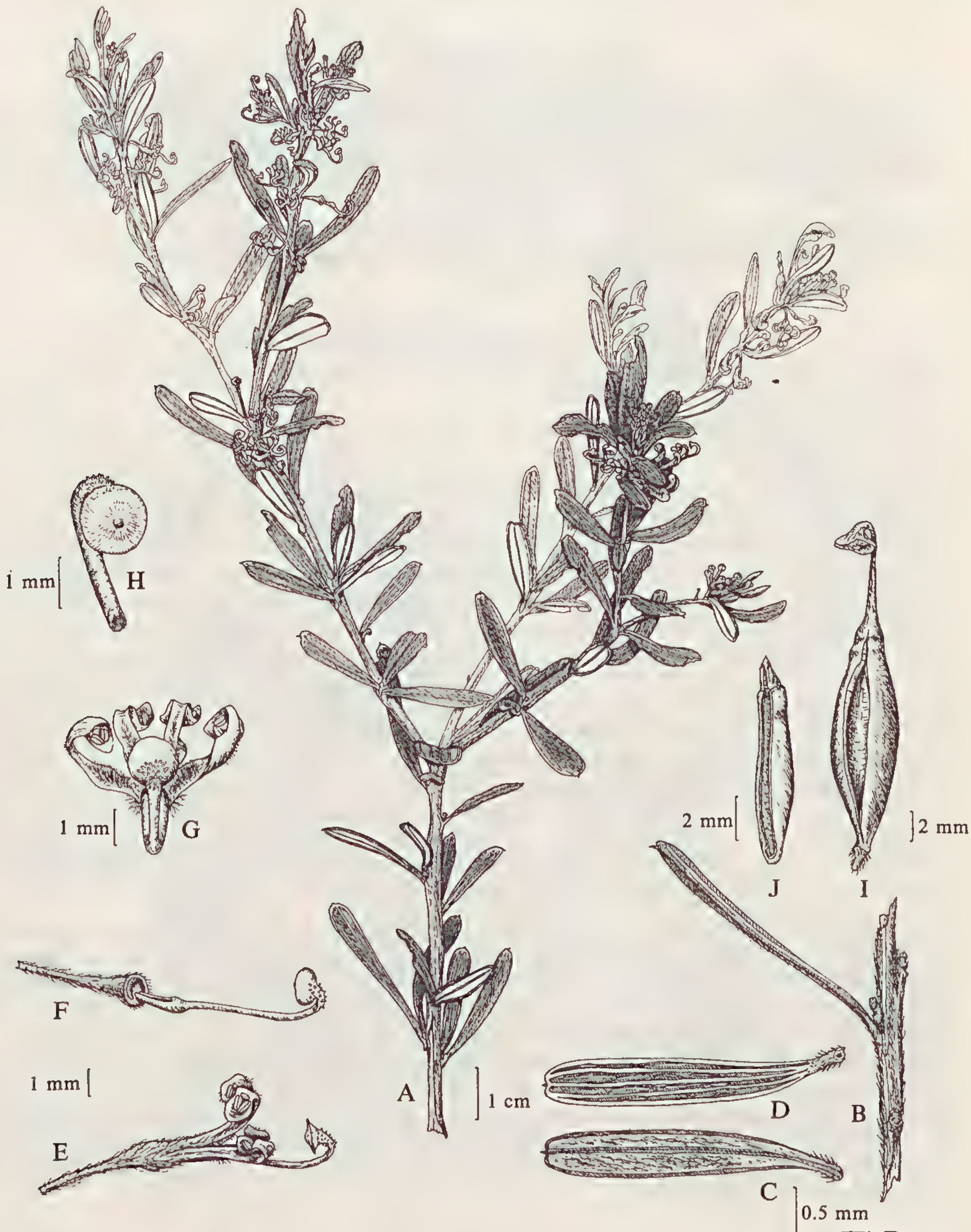
Illustration: A-H, based on fresh material preserved as *R. Davies & W. Bushman 289*, 23.x.1983, Shackle Road, Flinders Chase, Kangaroo Island (AD); I-J, based on herbarium specimen *T. Dendy 104*, xii.1980, Hundred of Gosse, Kangaroo Island (AD).

Shrub to 1 m high; branchlets appressed-tomentose with 3 glabrous ribs decurrent from each leaf base, the two outer ribs extending to node below, the middle to the next node down. *Leaves* rigid, coriaceous, ascending, simple, shortly petiolate, narrow-oblong to obovate, (1.5) 2.3-4.2 (5.5) x (0.2) 0.25-0.7 (0.8) cm, recurved, broad-obtuse to truncate with mucro c. 0.5-1 mm long, upper surface sericeous when young, soon glabrous, *in vivo* recurved with prominent midrib and 2 (3) parallel veins inside margin on either side interconnected by less prominent reticulate venation, *in sicco* revolute with parallel venation often obscure, lower surface sericeous. *Flowers* (4) 5-7 (8) in umbelliform axillary clusters on sericeous rachis 2-3.3 mm long; bracts and pedicel densely sericeous, the pedicel (3.8) 4-6 (7.5) mm long; torus horizontal, perianth pale to deep pink, sparsely sericeous outside towards base and on limb, densely woolly inside above ovary, glabrous above and below, in bud cylindrical, recurved, 4-5.5 mm long, limb 1.2-1.5 mm long; anthers 0.6-0.7 mm long; gland almost circular, (0.5) 0.6-0.8 mm diameter, c. 0.2 mm high, denticulate; pistil if straightened 8-9 (9.5) mm long, ovary midgreen, borne on grooved stipe 0.5-1 mm long, style pale to deep pink, grooved, reflexed, papillose at apex and behind the oblique broad-elliptic thin discoid pollen-presenter 1.3-1.6 x 1.1-1.4 mm, stigmatic region on tiny central cone. *Fruit* a pedicellate glabrous follicle, obliquely ovoid, 1.3-1.5 x 0.4-0.5 cm, tapering into persistent terminal recurved style; young seeds 2, narrow-oblong, 7.2-8.3 x 1.8-2.4 mm, broadly grooved on one side, brown, glabrous to finely pubescent, with cream folded apical caruncle-like protuberance 1.5-3 mm long.

Grevillea quinquenervis is confined to the western half of Kangaroo Island, where it is common on lateritic soils in a variety of plant associations ranging from *Eucalyptus remota* tall open shrublands with sclerophyll understorey to *E. obliqua* open forest (R. Davies, pers. comm. 1983).

An assessment of affinities must await the forthcoming revision of *Grevillea* by Mr D.J. McGillivray of the National Herbarium of New South Wales. Black (1909) placed his species in Sect. *Lissostylis* Ser. *Sericeae* of *Grevillea*, as delimited by Bentham (1870), and distinguished it from several species placed in this group. However, *G. quinquenervis* has similarities to another Kangaroo Island species *G. pauciflora* R. Br., which was placed by Bentham (l.c.) in Sect. *Plagiopodia*. Both species are shrubs similar in their habit, broad recurved leaves, few-flowered umbellate inflorescences, the ring of tomentum inside the perianth at the level of the ovary apex, the glabrous ovary and the oblique discoid pollen-presenter. *Grevillea pauciflora* is a species of southwest Western Australia and the peninsula region of South Australia. On Kangaroo Island, from the few collections available, it seems more widespread than *G. quinquenervis*. The two species would appear to be as common locally, but *G. pauciflora* prefers soils associated with limestone (R. Davies, pers. comm. 1983).

It is therefore not surprising that the two species have been confused with each other in identification, particularly as the distinctive parallel venation of *G. quinquenervis* is often obscured in dried herbarium material, this being the sole diagnostic character used by Black (1924, 1948) in his *Flora*. *G. quinquenervis*, however, is readily distinguished by its conspicuously ribbed branchlets; in *G. pauciflora* the branchlets are terete with an even covering of hairs. Furthermore, the T-shaped hairs which make up the indumentum in these and other species of *Grevillea* are shorter in *G. pauciflora*, and *G. quinquenervis* has an unusual patch of papillae extending from the style apex to the rear of the pollen-presenter. Further distinguishing features in *G. pauciflora* are its smaller flowers with a red



Grevillea quinquenervis J. Black A, habit; B, branch and leaf in lateral view; C, D, leaf, lower and upper sides; E, F, flower in lateral view, with and without perianth; G, flower in distal view; H, style end; I, dehisced follicle; J, seed.

perianth and style, yellow pollen-presenter, oblique torus, perianth tube dilated in the lower half, a semi-annular gland, and the upturned margins of the pollen-presenter.

References

Bentham, G. (1870). Proteaceae. *Fl. Australiensis* 5, 315-584.
Black, J.M. (1909). Description of *Micrantheum demissum* and of new species of *Solanum*, *Pultenaea* and *Grevillea*. *Trans. Proc. Rep. R. Soc. S. Austral.* 33, 223-225, pl. 14.
Black, J.M. (1924). Proteaceae. In 'Flora of South Australia'. (Govt Printer: Adelaide), pp. 157-166.
Black, J.M. (1948). Proteaceae. In 'Flora of South Australia, 2nd edn'. (Govt Printer: Adelaide), pp. 261-272.

W.R. Barker
State Herbarium of South Australia

Del. G.R.M. Dashorst
State Herbarium of South Australia

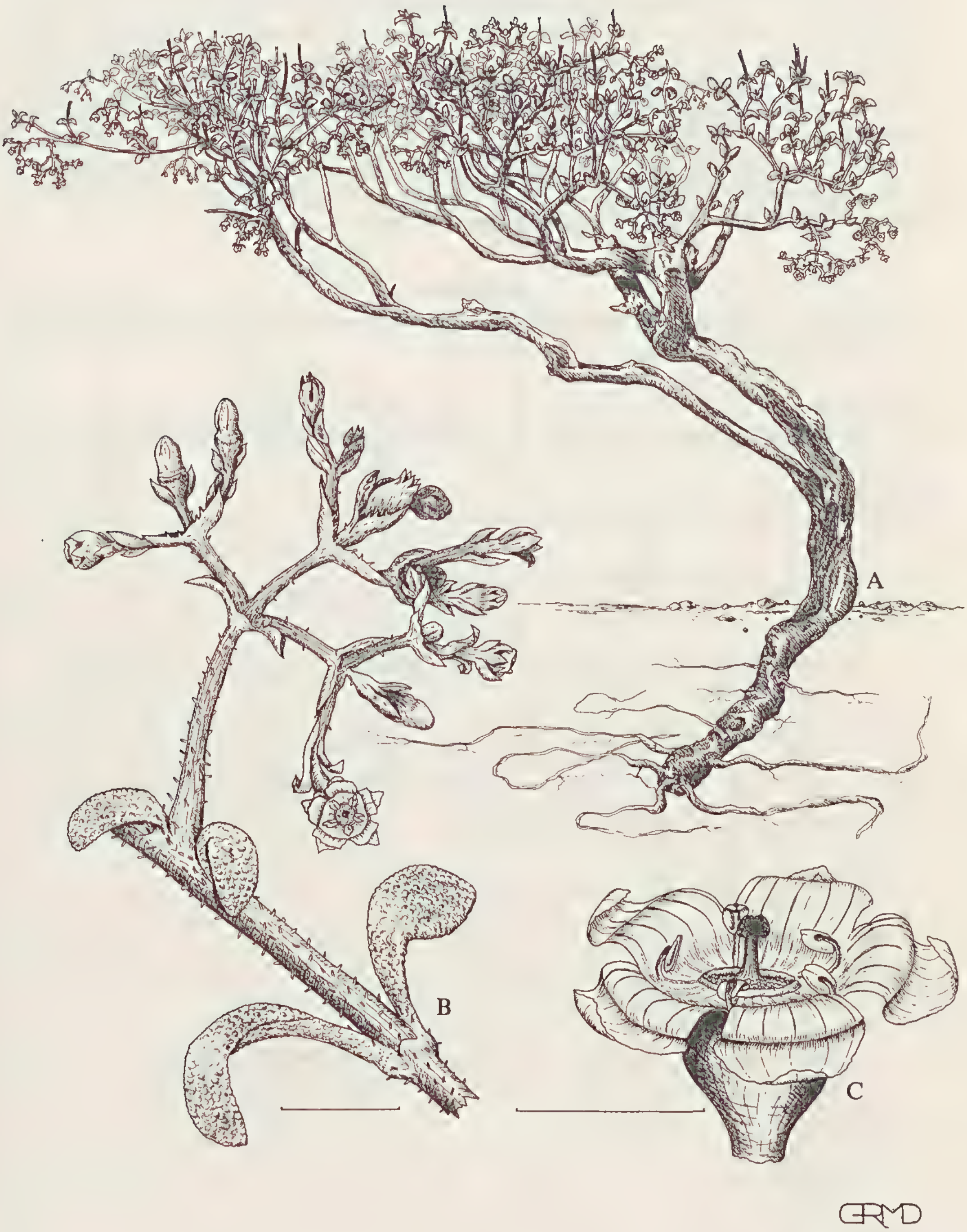
12. Logania insularis J. Black (Loganiaceae)

Logania insularis J. Black, *Trans. & Proc. R. Soc. S. Aust.* 50: 285 (1926); Fl. S. Aust. edn 2, 689, fig. 974 (1957).

Illustration: Based on fresh material preserved under *R. Davies & W. Bushman 131*, 8.x.1983, NW Cape Borda Lighthouse, Kangaroo Island (AD).

Delicate subshrubs or ground cover plants to 30 cm high, often with gnarled woody base; young branches covered with short stout spreading hairs and often soil-covered, glabrous later. *Leaves* opposite, petiolate to almost sessile; interpetiolar stipules broadly triangular, with one to few hairs along the margin but often becoming ill-defined on older branches; petiole up to 2.5 mm long, usually with a few short marginal cilia; lamina oblanceolate 3-8 x 1-2 (-3) mm, with cuneate base, acute to obtuse and usually more or less recurved at the apex, glabrous except for a few hairs along the recurved margins and on the raised central vein of the lower surface, thick to leathery, with upper surface at least colliculate to aculeate. *Inflorescence* a terminal thyrse with 1-5 dichasia each with few pedicellate flowers, more or less curved downwards and often overtopped by axillary branches; bracts linear-oblanceolate, fleshy to almost membranous, with few marginal cilia, acute. *Calyx*: lobes 5, lanceolate, c 1 mm long, membranous, with few to many marginal cilia. *Corolla* shallowly cup-shaped to almost saucer-shaped, cream to pale yellow; lobes usually longer than tube, obtuse to rounded, recurved-spreading. *Stamens* 5, with filaments incompletely fused to the lower parts of the corolla tube. *Ovary* superior or slightly sunk and with flat rough apex; style simple, with capitate bilobed stigma. *Fruit* not seen.

A very distinctive species in the genus because of its inflorescence which is curved downwards and cup- to saucer-shaped corolla which lacks hairs on the inside. At the base of the corolla lobes one finds a more or less clearly defined ring of fine papillae. The flowers of *L. insularis* are similar to those of *L. linifolia* which is widespread in the south-eastern parts of South Australia and adjoining parts of Victoria and New South Wales. Both species also have a rather loosely branched inflorescence and the leaf surface is colliculate at least on young leaves of *L. linifolia*. It is not clear why Black (1926) compared *L. insularis* with *L. buxifolia* F. Muell. in the original publication when the two are quite different. However, *L. linifolia* is also easily distinguished from *L. insularis* by its shrubby habit up to 1 m tall, the linear-elliptic leaves which are 10-20 mm long, the black calyx and the tubular corolla.



Logania insularis J. Black. A, habit; B. inflorescence; C, flower. (Scale = 5 mm).

Only one population of *L. insularis* has been found to date despite an extensive search by R. Davies, who provided the following field notes. This population is confined to an area of approximately 3 km^2 at Cape Borda where it occurs in pockets of pale brown sand (pH 7) between sheet limestone. The species occurs there under *Eucalyptus diversifolia* which ranges from open-heath to tall shrubland on an undulating plateau which slopes towards the sea cliffs to the north-west and north. Other species frequently occurring in association with *L. insularis* are *Allocasuarina muelleriana, Hibbertia aspera, Lepidosperma viscidum, Lhotskya glaberrima, Petrophile multisecta, Spyridium halmaturium.*

Since the species is extremely restricted in its distribution and only a small percentage of the total population is conserved in Flinders Chase National Park, it is considered to be vulnerable as defined by Leigh, Briggs & Hartley (1981).

Reference

Leigh, J., Briggs, J. & Hartley, W. (1981). 'Rare or threatened Australian plants'. (Australian National Park & Wildlife Service: Canberra).

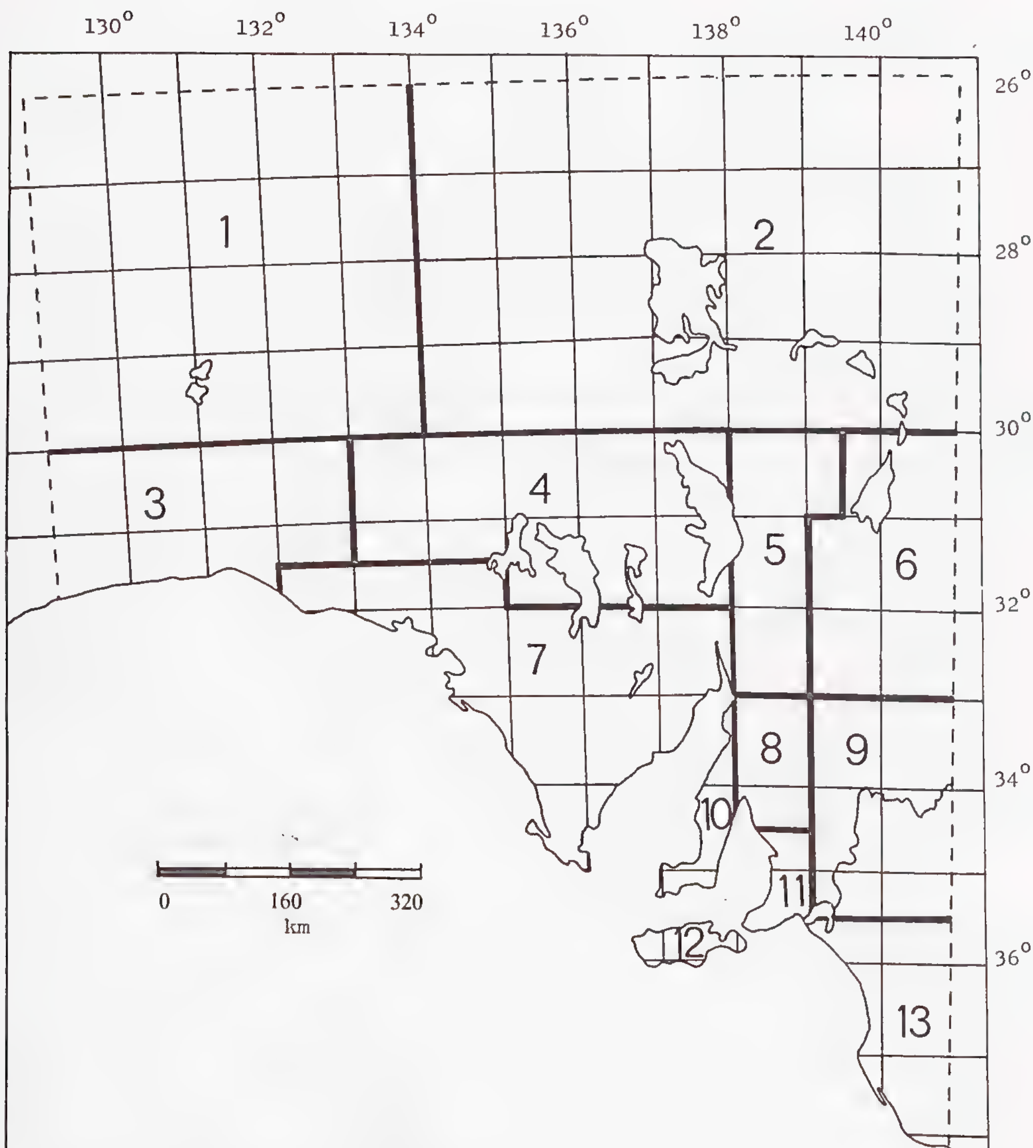
H.R. Toelken
State Herbarium of South Australia

Del. G.R.M. Dashorst
State Herbarium of South Australia

R.J.P. Davies
Conservation Council of South Australia Inc.

REGIONS OF SOUTH AUSTRALIA ADOPTED BY THE STATE HERBARIUM — ADELAIDE

1. North-western
2. Lake Eyre Basin
3. Nullarbor
4. Gairdner-Torrens Basin
5. Flinders Ranges
6. Eastern
7. Eyre Peninsula
8. Northern Lofty
9. Murray
10. Yorke Peninsula
11. Southern Lofty
12. Kangaroo Island
13. South-eastern



Typeset by P. & L. REPRODUCTIONS PTY. LTD.
Printed by AUSTRALIAN PRINTING SPECIALISTS

JOURNAL of the ADELAIDE BOTANIC GARDENS

CONTENTS

JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 7 Part 2

27 March, 1985

Instructions to Authors

Topics

Papers will be accepted in the following categories:

(a) Plant systematics (Australian and horticultural groups); (b) Descriptive plant morphology, anatomy and ecology; (c) Obituaries, biography and history; (d) Bibliographic studies, book reviews; (e) Botanical illustrations; (f) Noteworthy horticultural contributions. Preference will be given to unpublished material of suitable standard not intended for publication elsewhere.

Copy

Manuscripts must be typed, with double spacing and margins at least 3 cm wide, on one side of the paper only. Three copies must be submitted. Captions must not be italicized, underlined or typed in capitals. All scientific names of generic or lower rank must be underlined.

The print area for illustrations is 18 x 13 cm (excluding captions). Half-tone material should be submitted this size if possible, but will be reduced by the printers, if necessary.

Reprints

50 copies of reprints will be provided for each paper. Additional reprints may be purchased at cost.

Layout

The pattern of the paper should generally be:

(i) Title; (ii) Author and Address; (iii) Abstract (except for short papers); (iv) Introduction and subject matter; (v) Acknowledgements; (vii) References.

References

Text references to publications should be indicated as follows: (Smith, 1959), (Smith, 1959, p. 127), Smith (1959) or Smith (1959, pp. 125-208). The final section of the paper, headed 'References', should include only those titles referred to in this way. It should be laid out as follows:

Smith, L. L. (1879). The species of *Danthonia* found in pastures in Victoria. *Austral. J. Bot.* 65: 28-53.

Bentham, G. (1868). "Flora Australiensis", Vol. 4. (L. Reeve: London).

Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).

Journal abbreviations must be consistent within a paper and authors are recommended to follow "Botanico-Periodicum-Huntianum". Journals not cited in B-P-H should be abbreviated to conform with this general pattern. The following abbreviations for Australian states should be used: WA, NT, SA, Qld, NSW, ACT, Vic., Tas.

Text references to specimens should be italicized, for example *Kock 276*.

Indices

When required, follow the pattern on, for example, p. 106 of vol. 1, pt. 2.

Recommendations on taxonomic papers

Synonymy

Authors are requested to include in the synonymy only references to publications containing information additional to that to be published in the paper being submitted. Within this section journal and book titles must be conistently abbreviated. B-P-H journal abbreviations and book titles abbreviated in a similar way are desirable. Authors of references cited in the synonymy should preferably be abbreviated according to the 'Index of Author Abbreviations' compiled and published by Royal Botanic Gardens, Kew (1980). References may be cited as:

Benth., *Fl. Austral.* 4: 111 (1868) OR

Benth., *Fl. Austral.* 4: (1868) 111.

Citation of specimens

10-30 specimens should be cited for each species (or subspecific taxon), although this may be varied under certain circumstances. The author may decide whether or not to include dates of collections and the sequence, provided a constant pattern is adhered to throughout a paper.

Authors wishing to cite all specimens seen may list them all in an index to collectors after the style of the "Flora Malesiana" identification lists. Collections not identifiable by a collection number (assigned by either the collector or herbarium) should cite dates.

Correspondence

All correspondence concerning the journal should be addressed to:

The Director, Adelaide Botanic Gardens, North Terrace, ADELAIDE, South Australia 5000.

ISSN 0313-4083

J. Adelaide Bot. Gard. 7(2): 145-157 (1985)

THE SPREAD OF NATIVE AUSTRALIAN PLANTS AS WEEDS IN SOUTH AUSTRALIA AND IN OTHER MEDITERRANEAN REGIONS

P.M. Kloot

S.A. Department of Agriculture, G.P.O. Box 1671, Adelaide, South Australia, 5001

Abstract

The native vegetation of South Australia is ill-adapted to survive disturbance such as that imposed by agriculture. Yet 10 species unintentionally introduced and 16 species deliberately introduced from other parts of Australia are established to a greater or lesser extent in South Australia. Furthermore, 15 species native to South Australia have survived the disturbance caused by agriculture and in some cases have become minor weeds.

Apart from the intentionally introduced species which are mainly woody ornamentals, the other groups consist entirely of plants having herbaceous habits. Of the 50 Australian native plants established successfully in areas overseas with a Mediterranean climate similar to that of South Australia, the majority are woody ornamentals. The reasons for this are discussed in the paper.

Introduction

The native flora of Australia is ill-adapted to withstand most of the changes wrought by cultivation, fertilizing, grazing by ruminants and rodents and competition provided by alien plants. Consequently, native plants are not a prominent part of the weed flora, in marked contrast to the importance of native plants as weeds of agriculture in North America (Reed and Hughes, 1970) and South Africa (Wells *et al.*, 1982).

In this paper plants native to Australia which have become established in South Australia, or persisting after land clearing to become regarded as adapted to present farming patterns, are compared with the Australian species which are now established in some other regions of the world enjoying a Mediterranean climate similar to that of South Australia.

The degradation of native vegetation

The inability of many native Australian plants to tolerate the levels of soil phosphate produced by the application of superphosphate has been discussed by many authors (e.g. Specht, 1963) and will not be re-examined here. The severe grazing effects of ruminants on native grasses have been ascribed to their elevated growing points which are eaten or trampled. In contrast the growing point of species adapted for grazing are at or below the ground surface, beneath the level at which animals normally graze (Moore, 1957). Whilst the native grasses survive the browsing of the native Australian marsupials, they are vulnerable to the grazing of rodents and ruminants, particularly rabbits and sheep, and there are many records of the disappearance of native grasses following European settlement of the grasslands of southern Australia (e.g. Tiver and Crocker, 1951; Moore, 1957).

The effects of cultivation *per se* have not been documented to any extent, but Moore (1957) presented data obtained from native pasture near Goulburn, N.S.W., showing that cultivation of the native perennial grasslands resulted in the elimination of the native species and their replacement by aliens. He also commented that the area is likely to regenerate if the disturbance is removed before erosion occurs. In practice this would mean virtually no disturbance beyond the initial clearing.

Analyses of lists of native and introduced species in various plant associations in South Australia reveal that the native vegetation is predominantly perennial, but the successful

Table 1: A comparison of the proportions of annuals and perennials in the native and introduced flora of various land systems in South Australia (Figures in brackets are percentages of the total number of species).

No. of Associations listed		No. of Species	No. of Perennials & Geophytes	No. of Annuals
"Sclerophyll" land systems				
8	Native	336	324 (96.4)	12 (3.6)
	Introduced	35	17 (48.6)	18 (51.4)
"Mallee" land systems				
13	Native	414	389 (94.0)	25 (6.0)
	Introduced	40	9 (22.5)	31 (77.5)
Arid Lands				
15	Native	227	180 (79.3)	47 (20.7)
	Introduced	5	0 (0.0)	5 (100)
"Savannah" land systems				
7	Native	258	223 (86.5)	35 (13.5)
	Introduced	147	53 (37.4)	92 (62.6)

— Summarised from the appendices to Specht (1972).

aliens are mainly annual (Table 1). The former are not adapted to cycles of cultivation whilst the latter are. Thus the response of each native vegetation association as a whole to the disturbance of cultivation is to disintegrate, leaving remnants along fencelines, roadsides and in other uncultivated areas.

Annual species which might have the potential to survive have still to cope with the environmental hazards of grazing, trampling, fertilizer applications and unsuitable seedbeds apart from any inherent biological factors such as low seed production or seed dormancy.

Native species spreading or persisting in South Australia

In spite of the difficulties, a number of Australian native species have become established in the heavily modified environment of the South Australian settled areas. The native species involved fall into three groups: unintentionally distributed, deliberately planted and locally persistent species.

1. Unintentionally distributed species

This group of 10 species includes those first to be established. These plants travelled mostly by stock movements, although as noted, other means were involved in one or two cases.

(*Adenostemma viscosum* Forst.

A native of sub-tropical Australia which was collected near the Murray mouth by Mueller in 1849 (Bentham, 1867), but never since. This was probably a short-lived infestation associated with coastal shipping (Kloot, 1983), and is only mentioned here because of Bentham's reference to it.)

Brachiaria notochthona (Domin) Stapf

Originally native to the interior of Australia, small populations are now established on Yorke Peninsula, at Roseworthy, Gawler and in some suburbs of Adelaide. It was recorded by

Tate (1890) as *Panicum helopus* only for the interior and north-west pastoral areas, and collected in southern areas only after 1960. It is probably associated with sheep movements as it was noted as a wool-adventive in Central Europe (Probst, 1949).

Chloris truncata R. Br.

It was originally native to the interior, but is now widely established throughout South Australia. It is common in the Adelaide area, but it was rare there in 1909 when Black (1909) noted it as only known from near the Grange railway line. Tate (1890) had recorded it from the far north and north-west of the State and I suggest that it was moved by sheep. It is also a common wool-adventive in Central Europe (Probst, 1949).

Cyperus brevifolius (Rottb.) Hassk.

This species is native to persistently wet areas in eastern Australia. It is a major lawn weed there and is found from time to time in lawns in the Adelaide area (Kloot, 1979).

Cyperus rotundus L.

The original range of this widespread tropical species extends to northern Australia. It was distributed by mistake for *C. esculentus*, and was also brought to South Australia as a contaminant of soil around nursery stock imported from New South Wales (Kloot, 1979). It is now well established in the metropolitan area of Adelaide.

Cyperus sanguinolentus Vahl

A native to swampy areas of eastern Australia and possibly introduced to South Australia in association with cattle movements (Kloot, 1979). A number of patches have persisted for many years on the Fleurieu Peninsula.

Euphorbia tannensis Sprengel ssp. *eremophila* (Cunn.) Hassall

Originally it was found in the northern parts of the State but now it is occasionally collected from near Adelaide area where short-lived populations consisting of a dozen or fewer plants are established from propagules brought from the north.

Sclerolaena birchii (F. Muell.) Domin

Although originally found in restricted areas of New South Wales and Queensland it is now spread widely in those States on land degraded by over-grazing. In spite of a policy of eradication when found, reports of its presence are increasing from the upper and mid-north of South Australia where it has been introduced adhering to sheeps' fleeces from the eastern States.

Solanum capsiciforme (Domin) Baylis

The original range of this plant extended eastward from Western Australia to Eyre and Yorke Peninsulas and Kangaroo Island. Since 1967 however, this species has been collected increasingly from sites east of St Vincent Gulf including a patch about 15 kilometres east of the River Murray on the road to Waikerie. Stock transport has been implicated in this spread. (D.E. Symon, pers. comm.).

Solanum cinereum R. Br.

This species is established in the western Flinders Ranges around Melrose from where it is spreading southwards (Symon, 1976). It was probably introduced in contaminated fodder or attached to stock from New South Wales where it is a minor weed.

Zaleya galericulata (Melville) H. Eichler

Early records (e.g. Tate, 1890) suggest that this species was originally found in the northern parts of the State, but stock movements have introduced it to Eyre Peninsula, the northern cereal areas and the Mallee. In these areas it has been frequently reported by land holders from their properties in recent years.

2. Intentionally established species

These 16 plants were introduced as ornamentals from other parts of Australia, escaped and became naturalised in higher rainfall areas, i.e. receiving more than 400 mm per annum. Although some were early introductions to horticulture, they took longer to become established beyond cultivation than the species in the previous category; in fact most had a lapse of about a century. The upsurge in the cultivation of native Australian plants during the last 30 years could lead to the naturalisation of more such species in the future.

Acacia baileyana F. Muell.

Although native to a very small area of New South Wales, near Cootamundra and Wagga, it was named by Mueller from a specimen taken from an ornamental tree growing in Bowen Park, Brisbane (Mueller, 1888). Another specimen at MEL! from the Paramatta River collected by Woolls in 1887 must have also been collected from a planted tree.

Prior to Mueller recognising and describing *A. baileyana* as a new species, it had been confused with the Queensland species *A. polybotrya*. My conclusion is that *A. baileyana* must have been collected from the wild and cultivated in various places, prior to Mueller's publication. Locally, a specimen collected by Brummitt from near Clare in 1895 (MEL!) was annotated "Possibly strayed from an old garden", which implies that it had been cultivated earlier. It must have been grown under an incorrect name, probably that of another bipinnate-leaved species e.g. *A. decurrens* or *A. dealbata*, both of which had been introduced earlier. There is no record of any attempt to grow *A. polybotrya* in South Australia. *A. baileyana* is now successfully established in the Mt Lofty Ranges, from where it was collected first as an escape in 1943. It is possibly more widespread although a record from Lochiel in mallee clearings seems doubtful. Natural hybrids with both *A. dealbata* and *A. decurrens* are known from the Mt Lofty Ranges.

Acacia cyclops Cunn. ex Don

This species is native to southern coastal areas of Western Australia and the far west coast of South Australia. It was introduced to British horticulture as early as 1824 (Loudon, 1830), but no record of it in South Australian horticulture earlier than that of Schomburgk (1871) was found. It is occasionally found on Yorke Peninsula, on the adjacent northern Adelaide Plains and on Kangaroo Island.

Acacia dealbata Link

The original range of this species was from central New South Wales south to Victoria, but it has been widely planted throughout Australia as an ornamental. It was introduced to the Adelaide Botanic Gardens by 1859 (Francis, 1859), having previously been in cultivation in England since 1823 (Loudon, 1830). It is now found widely in the Adelaide Hills around Stirling and also near Coonawarra in the south-east. A natural hybrid with *A. baileyana* has also been collected (AD!).

Acacia decurrens (Wendl.) Willd.

This ornamental was a comparatively late introduction from the eastern States (Schomburgk, 1871). It has escaped to a minor extent in the southern Mt Lofty Ranges and near Mt Gambier. A natural hybrid with *A. baileyana* has also been collected.

Acacia mearnsii De Wild.

This species is native to the eastern States and its range extends westward to the south-east of South Australia. As it was first described from cultivation in East Africa in 1925 it must have been first grown under the incorrect names of *A. decurrens* or *A. mollissima* (Whibley, 1980). Therefore it is uncertain as to when this species was introduced into cultivation. It has become sparsely established in the southern Mt Lofty Ranges and on Lower Eyre Peninsula.

Acacia paradoxa DC.

Although this is apparently native to the Mt Lofty Ranges, Adelaide Plains, Yorke and Eyre Peninsula and elsewhere (Whibley, 1980) as well as Kangaroo Island, it is the latter form which is relevant. This is a particularly thorny form, originally absent from the mainland. It was grown in the old Botanic Gardens in 1841 as "Kangaroo Island Acacia" (CSO, 1842). It had been appreciated early as a hedge plant (McEwin, 1843) and was in widespread use by 1850 (Yelland, 1970). Annotations on early herbarium specimens (e.g. AD 96871034) also refer to its use as a hedge. Bentham (1864) noted it as "an old inmate of gardens". It is likely that some of the locations mapped by Whibley (1980) for this species are actually records of escapes of the hedge form which are known from the southern Mt Lofty Ranges and occasionally elsewhere.

Acacia saligna (Labill.) Wendl.

A popular ornamental introduced early from Western Australia (Francis, 1859) which persists as scattered patches and single plants near Cleve, in the Adelaide area and in the south-east of South Australia.

Albizia lophantha (Willd.) Benth.

This was a very early introduction to South Australia from Western Australia for a two-year old specimen (Anon., 1841) was flowering in the old Botanic Gardens in 1841 (Bailey, 1841), and Mueller annotated a specimen from Adelaide in 1848 (MEL!) "Frequent in gardens". It is now found in the southern Mt Lofty Ranges, the Pt Lincoln area, the lower south-east and in the Investigator Archipelago off Eyre Peninsula. It has been suggested that this last location is a natural extension of its original Western Australian distribution (D.E. Symon, pers. comm.).

Ammobium alatum R. Br.

This native of central New South Wales had been introduced to English gardens by 1822 (Loudon, 1830) and to South Australia by 1859 (Francis, 1859). It is still grown in gardens. It was collected from a roadside at Bridgewater and consequently included in the alien flora (Black, 1909). Black's assessment was incorrect as it has never been recorded since and is only mentioned here because Black included it.)

Eucalyptus cladocalyx F. Muell.

Originally confined to three restricted areas of gravelly ironstones on Kangaroo Island, Eyre Peninsula and in the Flinders Ranges, this tree species has been very widely planted as an ornamental and for shelter-belts. From these plantings it has become sparingly naturalised in different parts of South Australia.

Hakea laurina R. Br.

An early introduction from Western Australia (Francis, 1859 as *H. eucalyptoides*) which has escaped from ornamental plantings at American River, Stonyfell, Victor Harbor and Belair.

Kennedya nigricans Lindley

This ornamental climber had been introduced by 1859 from Western Australia (Francis, 1859). It is naturalised in places in the southern Mt Lofty Ranges.

Leptospermum laevigatum (Gaertn.) F. Muell.

This shrub is native to coastal areas of New South Wales, Victoria and Tasmania. It was introduced before 1871 (Schomburgk, 1871) as an ornamental. It was also highly regarded as a sandbinder (Mueller, 1885) and may have been introduced for that purpose. It had escaped in the Victor Harbor area by 1926 (AD97137291!). It is still confined to pockets in the Victor Harbor and Port Elliot area and to small patches along the Adelaide coast between Grange and Outer Harbour. It has been found to be a vigorous invader of disturbed coastal areas in Victoria (Burrell, 1981), and may spread locally in the future.

Pittosporum undulatum Vent.

This shrub was an earlier introduction from New South Wales (Francis, 1859) and recommended as a hedge plant (Heyne, 1877). It is naturalised in the Stirling area of the southern Mt Lofty Ranges. Victorian experience suggests that this tree can compete vigorously with natural scrub (Gleadow and Ashton, 1981).

Solanum aviculare Forst. f.

A native of eastern Australia which was probably cultivated as an ornamental for its showy flowers and fruit. (D.E. Symon, pers. comm.). Locally naturalised on Eyre Peninsula.

Solanum laciniatum Ait.

A native of eastern Australia with a wide range which extends as far west as the Mt Lofty Ranges in South Australia. It has become established in the south-western extremity of Eyre Peninsula where it has spread from an abandoned homestead garden near Mt Dutton (C.R. Alcock, pers. comm.).

Sollya heterophylla Lindley

This Western Australian shrub was introduced to South Australia before 1859 (Francis, 1859) and is now firmly established near Stirling and Crafers in the southern Mt Lofty Ranges.

3. Locally persistent species

These 15 species or groups of species are native to the areas where they have successfully adapted to disturbed environments. In the cereal areas of South Australia a few native plants have managed to persist for long periods. In situations subject to disturbance but not cultivation, e.g. grazing, more native species are likely to be found, usually as diminishing relics of the original flora confined to scrub remnants, roadsides and similar pockets. Occasionally augmented populations may be favoured at least temporarily by the prevailing environmental conditions, e.g. *Danthonia* favoured by grazing and low soil phosphate levels (Tiver and Crocker, 1951; Moore, 1957), but such populations disappear with cultivation. Some annuals and short-lived perennials are able to persist even through such disturbance and these are noted below.

Some native plants have become prominent in recent years. Prior to their reappearance they had been rare in farming land but more common in the partially disturbed environments described above. It is suggested that they have become prominent for two reasons. Firstly, with a trend to longer rotations and minimum tillage practices, there is less soil disturbance

which favours these native species. Secondly, it is suggested that the consistent use of herbicides (for over 30 years) has diminished the population of aliens and allowed these native species, which tolerate the herbicides that have been used, to build up their populations in the absence of competition from aliens.

Acacia longifolia (Andr.) Willd.

This shrub is native to coastal areas of south-eastern Australia. The variety *sophorae* F. Muell. is particularly well adapted to colonising unstable coastal dune systems. In recent years, it has become a nuisance in the south-east of South Australia where it invades disturbed soil on roadsides and farmland, necessitating chemical control.

Acaena anserinifolia (Forst. & Forst. f.) Druce

This perennial is native to southern Australia including the higher rainfall areas of South Australia (Tate, 1890) but it appears to have been spread by sheep into lower rainfall areas and through its range it has become more abundant.

Calotis erinacea Steetz

This perennial species is reported as occurring in large patches in cereal-growing land around Kimba on Eyre Peninsula. Chemical control is being used (J.A. Dickinson, pers. comm.).

Diplachne fusca (L.) Beauv.

A perennial grass native to northern Australia and extending as far south as the Murray River, where in recent years it has been reported as a weed of orchards near Renmark.

Erodium cygnorum Nees

This annual is occasionally found in annual pastures but, like its introduced cogeners, rarely if ever in crops.

Euphorbia drummondii Boiss.

An annual, poisonous plant frequently found in dryland pastures, but rarely in crops.

Haloragis spp.

These perennials are now reappearing in cropping land in northern Yorke Peninsula.

Oxalis spp.

Short-lived perennials which were previously included in *O. corniculata* L. The specific identity remains doubtful as the taxonomy of this group in Australia is still unsatisfactory. Commonly found in pasture, particularly in the second year or later. *Oxalis* had been noted by Behr (1847) as appearing in pastures as early as 1844-45.

Pimelia spp.

Although some records of these perennial species undoubtedly refer to relic populations surviving in rough grazing land, there are a number of confirmed records where *Pimelia* spp. carried in sheep's fleece have been reintroduced to irregularly-cropped land in the mid-north of South Australia. In some cases the infestations have grown to paddock size and interfere with cropping.

Rumex brownii Campd.

This native dock is a short-lived perennial which is widespread in pastures on Kangaroo Island, southern Eyre Peninsula and parts of the Lower North. It is sufficiently serious as to require control measures. Seedlings may compete with young crops.

Salsola kali L.

This annual seems to be a native form which detailed taxonomic investigations might establish as a separate taxon from the Eurasian species of the same name. It is found in marginal pasture land but is less common in the crop phase of the rotation.

Solanum esuriale Lindley

The southern portion of the range of this perennial extends into agricultural areas of Victoria and South Australia where it is widespread, thriving in pastures, particularly if irrigated, orchards and on roadsides.

Stipa spp.

Speargrasses have been found to invade poor pastures towards the margins of the South Australian cereal areas and beyond. Their unpalatability, particularly as they set seed, ensures that they are rejected by grazing stock and are able to spread more or less unimpeded. The species involved are perennials.

Vittadinia spp.

Spreading from roadsides into adjoining farmland in the Lower-North where, as short-lived perennials they take advantage of longer pasture phases in the crop-pasture rotation.

Zygophyllum spp.

An annual occasionally found in pastures but not in crops in marginal farming land east of the Mt Lofty Ranges.

The establishment of Australian plants overseas

It is both relevant and illuminating to extend this survey to include the naturalization of native Australian plants in other regions of the world having a Mediterranean climate similar to that of the settled areas of South Australia. Information from floras of the Mediterranean basin, South Africa and California is presented in Appendix I. There is a clear distinction between the deliberately planted ornamentals and the other species which have been noted as wool adventives in Europe (Probst, 1949; Clapham, *et al.* 1962). However in spite of the large shipments of wool from Australia to Europe, it cannot be concluded that this was the actual means of introduction which led to the present infestations of the various species. For example both *Acaena anserinifolia* and *Alternanthera nodiflora* were grown in British gardens (Loudon, 1830) and this, or perhaps some other way, could have been the source from which present populations have developed. Similarly although Munz and Keck (1959) indicate that *Atriplex muelleria* and *A. semibaccata* were introduced as fodder plants, Probst's (1949) records of the same species as wool aliens in Central Europe suggest another potential means of entry. Admittedly this would be less likely in the case of California as the amount of wool imported there from Australia is negligible.

The importation to South Africa and California of *Atriplex* spp. as potential fodder plants resulted from the lively programmes of plant exchanges, particularly of potentially valuable species, that flourished in the second half of the last century and the first decades of this.

In South Australia, each of the 10 unintentionally introduced species and each of the 16 locally persistent species has a herbaceous habit. This is consistent with their movement being mainly by sheep in the first case and of their finding a niche in agricultural systems in the latter. With the intentionally planted species however, only two (excluding *Ammobium alatum*) are herbaceous, the remainder being woody ornamentals.

However, of the 50 species (Appendix I) that are successfully established in Mediterranean areas overseas, only 14 are herbaceous, the other 36 being woody ornamentals which were

deliberately planted. This is not surprising when the various categories of plants that are succeeding in disturbed conditions in South Australia are compared with those succeeding overseas. There is little scope for the first group as there is no movement of live sheep from Australia to the areas under consideration. The third category of locally persisting plants is obviously irrelevent. This only leaves the group of intentionally introduced plants and this class both in South Australia and overseas consists predominantly of woody ornamentals. Up to 8 of the herbaceous plants were deliberately planted, so the importance of deliberate introduction is even greater. From these data we see that the overwhelming majority of Australian plants successfully established overseas are cultivated ornamentals, mostly woody.

By contrast the proportion of the aliens naturalised in Australia that are herbaceous in habit is much larger. In a checklist of naturalised alien plants of South Australia (Kloot, in prep.) a preliminary count revealed that about 780 of the 900 species listed are herbaceous.

Contaminated pasture seed imported to Australia is a potent source of herbaceous aliens from Europe. This particularly applied to last century when so many were introduced, but the threat still continues today. However there is no reciprocal movement of herbaceous native species for the recently developed export of Australian pasture seed to the Mediterranean basin, California and elsewhere, is based on certified seeds of high purity which are unlikely to contain Australian native plant seeds. The relatively few impurities are likely to be of species alien to Australia, that are able to survive under the conditions in which pasture seed crops are grown.

Apart from the species listed in this paper as being moved by sheep within Australia, Probst (1949) lists 172 endemic Australian herbaceous plants that have been recorded as wool-adventives in Europe. However, as shown in Appendix I only 5 of them are actually naturalised there—*Cotula australis, Limosella australis, Acaena anserinifolia, Alternanthera nodiflora* and *Tetragonia tetragonoides*—and the latter three are known also to have been introduced intentionally for horticultural purposes.

Although there are many Australian plants that can be dispersed effectively, few have become established overseas, even compared with the number that have become established in the similar climatic region of South Australia. Two reasons are suggested.

Firstly, sheep pick up plant propagules when grazing. Whether a live sheep is moved near or far, it is eventually returned to an open paddock and should the propagules fall from the fleece then they fall into an environment somewhat similar to where they originated. On the other hand, if the sheep is shorn or slaughtered only the fleece is moved with its load of plant propagules ("vegetable fault") to a factory and the propagules may never come in contact with the soil. In the past, wool shoddy has been used as a mulch in orchards and the like (Hayward and Druce, 1919) and where seeds have survived the wool-scouring processes they may germinate and become established, at least casually.

Secondly, as discussed at the beginning of this paper, most Australian plants are not well adapted to disturbance and compete poorly with plants that evolved in other parts of the world in disturbed conditions as found in agriculture. Furthermore, the herbaceous plants do not even have the advantage of height as do those woody ornamentals which have succeeded overseas.

It is noticeable that in the area of Mediterranean climate that has been the most degraded for the longest period i.e. the Middle East, very few Australian species have yet become established there according to the Floras and weed lists that have been located. Five chenopods originally introduced to Israel as potential fodders have become sparingly naturalised there on roadsides (Dafni and Heller, 1982). Even without their indigenous burden of predators and parasites, even the most aggressive Australian plants do not have sufficient vigour or the appropriate habit or growth cycle to compete.

The coincidence of names in Appendix I with those listed earlier for South Australia is significant. It suggests that a small number of Australian plants are sufficiently "agressive", or perhaps "weedy", to be able to compete successfully in disturbed ecosystems of similar structure in different parts of Australia, and indeed, in some parts of the world. It would seem worthwhile that quarantine measures should be enforced for those areas presently free of these particular species.

Acknowledgements

I am grateful to Mr D.E. Symon and Mr C.R. Alcock for their constructive comments on the manuscript.

References

Adamson, R.S. and Salter, T.M. (1950). "Flora of the Cape Peninsula". (Juta: Capetown).

Anon. (1841). The Torrens, its sources, its streams and its tributaries, No. III. *S.A. Magazine* 1: 123-128.

Bailey, J. (1841). Plants flowering in the Botanic Gardens, June, 1841. *S.A. Magazine* 1: 30.

Behr, H.H. (1847). Südaustralische Pflanzen I. Ueber die Verhältnisse der südaustralischen Flora im Allgemeinen. *Linnaea* 20: 545-558.

Bentham, G. (1867). "Flora Australiensis", vol. 3. p. 463. (Reeve: Ashford).

Black, J.M. (1909). "The Naturalised Flora of South Australia". (Adelaide).

Burrell, J.P. (1981). Invasion of coastal heaths of Victoria by *Leptospermum laevigatum* (Gaertn.) F. Muell. *Aust. J. Bot.* 29: 747-764.

Chater, A.O. and Walters, S.M. (1976). *Senecio*. In "Flora Europaea", vol. 4 (eds. T.G. Tutin *et al.*). (University Press: Cambridge).

Clapham, A.R., Tutin, T.G. and Warburg, E.F. (1962). "Flora of the British Isles". (University Press: Cambridge).

CSO (1842). Return of Trees and Shrubs in the Botanic Gardens. Colonial Secretary's Office 5/1842.

Dafni, A. and Heller, D. (1982). Adventive flora of Israel—Phytogeographical, ecological and agricultural aspects. *Pl. Syst. Evol.* 140: 1-18.

Davis, P.H. (ed.) (1965-1982). "Flora of Turkey and the East Aegean Islands", vols 1-7. (University Press: Edinburgh).

Francis, G.W. (1859). "Catalogue of the Plants and Cultivation in the Government Botanic Gardens, Adelaide, South Australia". (Government Printer: Adelaide).

Gleadow, R.M. and Ashton, D.H. (1981). Invasion by *Pittosporum undulatum* of the forests of Central Victoria, Australia. I. Invasion patterns and plant morphology. *Aust. J. Bot.* 29: 705-720.

Hayward, I. and Druce, G.C. (1919). "The Adventive Flora of Tweedside". (Abroath).

Henderson, M. and Anderson, J.G. (1966). Common Weeds in South Africa. *Botanical Survey of South Africa, Memoir* 37.

Heyne, E.B. (1871). "The Fruit, Flower and Vegetable Garden". (Andrews: Adelaide).

Kloot, P.M. (1979). The native and naturalised *Cyperus* species in South Australia. *J. Adelaide Bot. Gard.* 1: 333-341.

Kloot, P.M. (1983). Early records of alien plants naturalised in South Australia. *J. Adelaide Bot. Gard.* 6: 93-131.

Loudon, J.C. (1830). "Loudon's Hortus Brittanicus". (Longman: London).

McEwin, G. (1843). "South Australian Vigneron and Gardener's Manual". (Allen: Adelaide).

Meikle, R.D. (1977). "Flora of Cyprus", Vol. 1. (Bentham—Moxon Trust: Kew).

Moore, R.M. (1957). Some ecological aspects of the weeds problem in Australia. *Proc. 4th Inter. Congr. Crop Prot., Hamburg* 1: 447-449.

Mueller, F.J. (1885). "Select Extra-Tropical Plants, readily eligible for Industrial Culture or Naturalisation". (Government Printer: Melbourne).

Mueller, F.J.H. (1888). Description of some hitherto unknown Australian plants. *Trans. & Proc. Roy. Soc. Vic.* 24: 168-174.

Munz. P.A. (1968). "Supplement to A California Flora". (University of California: Berkeley).

Munz, P.A. and Keck, D.D. (1959). "A California Flora". (University of California: Berkeley).

Probst, R. (1949). "Wolladventivflora Mitteleuropas". (Vogt—Schild: Solothurn).

Reed, C.F. and Hughes, R.O. (1970). Selected Weeds of the United States. *U.S.D.A. Agriculture Handbook No. 366.*

Schomburgk, R. (1871). "Catalogue of the Plants under Cultivation in the Government Botanic Gardens, Adelaide, South Australia". (Government Printer: Adelaide).

Specht, R.L. (1963). Dark Island heath (Ninety-Mile Plain, South Australia). VII. The effect of fertilizers on composition and growth, 1959-60. *Aust. J. Bot.* 11: 67-94.

Specht, R.L. (1972). "The Vegetation of South Australia". (Government Printer: Adelaide).

Symon, D.E. (1976). The establishment and spread of *Solanum cinereum* R. Br., Narrawa burr, in South Australia. *S. Austral. Natural.* 51: 28-29.

Tate, R. (1890). "A Handbook of the Flora of Extratropical South Australia containing the Flowering Plants and Ferns". (Education Department: Adelaide).

Tiver, N.S. and Crocker, R.L. (1951). The grasslands of south-eastern South Australia in relation to climate, soil and development history. *J. Brit. Grassl. Soc.* 6: 29-80.

Tutin, T.G. *et al.* (eds) (1964-1980). "Flora Europaea", vols. 1-5. (University Press: Cambridge).

Wells, M.J., Engelbrecht, V.M. and Balsinhas, A.A. (1982). A preliminary analysis of South Africa's weed flora. *Proc. 4th Nat. Weeds Conf. S. Africa, 1981*, pp. 1-6.

Whibley, D.J.E. (1980). "Acacias of South Australia". (Government Printer: Adelaide).

Yelland, E.M. (ed.) (1970). "Colonists, Copper and Corn in the Colony of South Australia 1850-51". (Hawthorn Press: Melbourne).

APPENDIX I

Australian plants naturalised in other Mediterranean areas of the world

Species	Australian distribution	Europe	South Africa	California	Method of Introduction Deliberate*	Possible wool adventive
Acacia cultriformis A. Cunn.	Qld. & N.S.W.	Ref. 3			x	
A. cunninghamii Hook.	Qld. & N.S.W.	3			x	
A. cyclops Cunn. ex Don	W.A. & S.A.	1,3	4		x	
A. dealbata Link	S.E. Aust.	1,2	4		x	
A. decurrens (Wendl.) Willd.	E. Aust.		8	6	x	
A. ligulata Cunn. ex Benth.	Mainland Aust.	3			x	
A. longifolia (Andr.) Willd.	S.E. Aust. coasts	1,2,3	4	6	x	
A. mearnsii De Wild.	E. Aust.	1,2	4		x	
A. melanoxylon R. Br.	E. Aust. high rainfall	1,3	4	6	x	
A. paradoxa DC.	Southern Aust.		4		x	
A. pravissima F. Muell.	N.S.W. & Vic.	3			x	
A. pycnantha Benth.	S.E. Aust.	1,3	4		x	
A. retinodes Schldl.	S.A., Vic. & Tas.	1,2,3		6	x	
A. saligna (Labill.) H. Wendl.	W.A.	1,2,3	4		x	
A. verticillata (L'Her.) Willd.	S.E. Aust.	3			x	
Acaena anserinifolia (Forst. & Forst. f.) Druce	S.E. Aust.	1		7		9,10
Albizia lophantha (Willd.) Benth.	W.A.	3	4	6	x	
Alternanthera nodiflora R. Br.	Mainland Aust.	1				9
Atriplex lindleyi Moq.	Inland Aust.			6	x	
A. muelleri Benth.	Mainland Aust.		4		x	9
A. nummularia Lindl.	Mainland Aust.			6	x	
A. semibaccata R. Br.	Mainland Aust.		4	6	x	9

Appendix I *(Continued)*

Species	Australian distribution	Europe	South Africa	California	Method of Introduction: Deliberate*	Method of Introduction: Possible wool adventive
A. vesicaria Hew. ex Benth.	Mainland Aust.			7	x	
Bromus arenarius Labill.	? Mainland Aust.			6		9
Chenopodium pumilio R. Br.	Mainland Aust.			6		9
Cotula australis (Sieber ex Spreng.) Hook. f.	Southern Aust.	1		6		9
Danthonia pilosa R. Br.	Southern Aust.			6		9
Eucalyptus botryoides Sm.	N.S.W. & Vic. coasts	1			x	
E. camaldulensis Dehnh.	Mainland Aust.	1,2		7	x	
E. globulus Labill.	N.S.W., Vic. & Tas.	1		6	x	
E. gomphocephala DC.	W.A.	1			x	
E. lehmanii Preiss	W.A.		4		x	
E. polyanthemos Schauer	N.S.W. & Vic.			6	x	
E. resinifera Sm.	Qld & N.S.W. coasts	1			x	
E. robusta Sm.	Qld & N.S.W.	1			x	
E. rudis Endl.	W.A.	1			x	
E. tereticornis Sm.	East. Aust.	1		6	x	
E. viminalis Labill.	S.E. Aust.	1			x	
Hakea gibbosa (Sm.) Cav.	Qld & N.S.W.		4		x	
H. salicifolia (Vent.) B.L. Burtt	Qld & N.S.W.	1			x	
H. sericea Schrad. & Wendl.	S.E. Aust.	1	5		x	
H. suaveolens R. Br.	W.A.		4		x	
Helichrysum bracteatum (Vent.) Andr.	Throughout Aust.	1			x	
Leptospermum laevigatum (Gaertn.) F. Muell.	Vic, Tas, & N.S.W. coasts		4		x	
Limosella australis R. Br.	Southern Aust.	1				9
Myoporum insulare R. Br.	Southern Aust.	1	4		x	
M. tenuifolium Forst.	Mainland Aust.	1			x	
Oxalis exilis A. Cunn.	E. Aust.	1			x	
Pittosporum undulatum Vent.	N.S.W.	1			x	
Tetragonia tetragonoides Pallas (O. Kuntze)	E. Aust. coasts	1		6	x	9
Total Number of Species		35	18	19	43	10

* Deliberate introduction—as ornamentals, fodder plants or for tanning, sandbinding or swamp drainage purposes, based on one or more of the references shown.

Note: *Rumex brownii* Campd. is naturalised in Britain (10), although it is not recorded in

the "Flora Europaea" (1). It is native to southern Australia and is a wool alien (9,10). *Myriophyllum verrucosum* Lindl. is also recorded from Britain (10) but not recorded in the "Flora Europaea" (1). It is a plant of very wet areas cf. *Cotula australis, Limosella australis*, but its introduction in Britain is obscure. The record of *Senecio lautus* Sol. (10) is probably the South African species *S. inaequidens* DC. (see Chater & Walters, 1976).

References: 1. Tutin *et al.* (1964-1980)
2. Davis (1965-1982)
3. Meikle (1977)
4. Adamson & Salter (1950)
5. Henderson & Anderson (1966)
6. Munz & Keck (1959)
7. Munz (1968)
8. Whibley (1980)
9. Probst (1949)
10. Clapham, Tutin & Warburg (1962)

J. Adelaide Bot. Gard. 7(2): 159-166 (1985)

AN OBJECTIVE METHOD FOR ASSESSING THE PERFORMANCE OF AMENITY PLANTINGS

Brendan G. Lay and Anthony P. Meissner

S.A. Department of Agriculture, 25 Grenfell Street, Adelaide, South Australia, 5000

Abstract

This paper describes the conceptual development, use and statistical validation of an objective method by which the performance of broadscale shrub and tree plantings for amenity purposes can be determined. The method provides an evaluation of the performance of specimens in relation to their potential on a species basis. It gives consistent results on the relative performance of species planted at a particular site and under particular horticultural treatments. The paper also highlights the need to statistically test the repeatability of subjective assessments used in other amenity plant surveys, particularly those used for monetary valuations.

Introduction

Amenity can be defined as "the subjective human assessment of pleasantness". As such, it is easy to perceive why those attempting to put amenity values on horticultural plantings have experienced so many problems in producing a universally acceptable and repeatable method. Many attempts have also been made to develop methods for determining tree value in monetary terms; these have been reviewed by Raad (1972) and Wycherley (1979). The primary aim of all these methods was to establish an objective basis for the assessment of amenity value in monetary terms of individual trees or shrubs to people living in the locality. The approach taken in these methods has been to determine the size and condition of the tree, then assess the significance of its location and finally to combine, usually by multiplication, these factors with a money index to determine a final monetary value. The methods, in effect, attempted to provide objectively based criteria to define a subjective concept. Since all the methods were trying to achieve the same goal, viz. the determination of a realistic monetary value of an individual plant which can stand up in legal proceedings, then one method should be agreed to and adopted by all responsible bodies in Australia. However, this is not the case. At present there are at least three approaches being used in different parts of Australia all based on techniques developed overseas. These methods cover trees only and are described by Boomsma (1973), Australian Institute of Horticulture (1977) and Kartzoff (1977).

There are two serious weaknesses in all the currently used methods of amenity tree valuation: (a) the final monetary value is derived by multiplying a number of factors together and hence an error in one factor is compounded in the calculation and (b) there has been no attempt to determine repeatability of any method by different observers. This need has been recognised. For example the Australian Institute of Horticulture Committee report (1977) states that the elimination of bias ". . . is regarded as most important, particularly to ensure some uniformity of judgments from different valuers and to minimize the spread of subjectively assessed results". Despite this, to our knowledge, no evaluation of assessment methods, statistical or otherwise, has been published.

This paper describes an objective method of assessing performance of amenity plantings. The individual trees or shrubs are assessed and scored with reference to optimum observed performance for that species in cultivation under field conditions. No reference is made to significance of location or monetary value. As such it avoids most of the subjectivity of the above methods. In this respect it is similar to methods used in some overseas surveys. For example Good *et al.* (1978) in a broadscale survey of amenity trees, classified plants on a species basis but made no attempt to determine their condition.

Developing the method

The need to develop a method for objectively assessing amenity plantings arose in 1979 when we were asked to evaluate the performance of individual plants at a variety of locations in South Australia. It soon became obvious that evaluation of the elusive characteristic "amenity value" could not be done by physical measurement alone. For example, a healthy slow growing specimen should score more highly than one which has grown faster but was subject to wind damage, was diseased, or looks unsightly. In addition, any useful method had to be practical, because individual plant ratings needed to be performed rapidly. At one site, for example, about 12,000 trees were assessed. Physical measurements would have been too time consuming.

The method as conceived uses two criteria, health and vigour, which together indicates the performance of trees or shrubs anywhere at any time. Health is assessed by rating the plant on a scale of 0-5 relative to a completely healthy and undamaged specimen, while vigour, or rate of growth of the plant is also scored on a similar scale with reference to maximum expected growth for that species under cultivation. This requires that observers should have some knowledge of expected growth rates of individual species at a given age. Observers who are unfamiliar with the species assessed can gain a reasonable idea of anticipated growth rates by referring to the species or taxon in published works, in botanical gardens, or by comparison with other plantings of known age where that taxon is represented. The optimum growth rates refer to the best growth commonly seen in cultivation, or locally observed, rather than to the optimum in its natural environment.

Trunk form as used in forestry assessments was not considered relevant as it is unrelated to amenity value. However, height and girth measurements can be correlated with vigour ratings for estimates of timber volume.

Table 1. Criteria used in rating plants for amenity purposes.

(a) HEALTH SCALE (0-5)

0.			Plant dead
1.		(a)	No foliage, stems still green
	or	(b)	100% dieback or supression of terminal foliage, any new growth or resprouts unhealthy, chlorotic or absent.
2.		(a)	100% dieback or supression of terminal foliage, new growth or resprouts healthy.
	or	(b)	Apparently chronic or systemic infection or dessication with 75-100% of foliage dead, lost or damaged.
	or	(c)	Two or more of the factors under "3" below.
3.		(a)	Whole plant showing chlorosis, including new growth.
	or	(b)	Most leaves lost on lower growth, healthy tip growth remaining.
	or	(c)	50-70% of foliage affected by disease and/or dessication.
	or	(d)	Death or dieback of a major stem or portion of canopy; remainder healthy.
4.		(a)	Healthy plant but with significant (25-50%) leaves lost or damaged.
	or	(b)	Healthy, with minor stem or canopy damage (affecting less than 25% of plant).
	or	(c)	Chlorosis of non-terminal foliage.
	or	(d)	Slight ill-thrift generally apparent.
5.			Healthy, but includes plants with up to 25% of leaves damaged in some way.

Table 1 *(continued)* **(b) VIGOUR SCALE (0-5)**

0.			Plant dead.
1.		(a)	No recent increase in canopy; size less than 25% of optimum.
	or	(b)	New growth, but plant less than 10% of optimum.
2.		(a)	Growth less than 25% of optimum, new leaves but only slight recent increase in canopy size.
	or	(b)	Growth less than 25% of optimum, major stem resprouting.
3.			Growth 25-50% of optimum.
4.			Growth 50-75% of optimum.
5.			Growth 75-100% of optimum.

The method was field tested and modified to cater for most field situations. The final list of criteria is shown in Table 1. As can be seen from this table, the intention was to cover all commonly observed variations in plant performance with no direct measurements necessary. Where percentages are mentioned, they refer to linear proportions. For example, a tree growing at 50% of the optimum is, on average, half the height and half the canopy diameter of the optimum standard. A plant of maximum expected canopy diameter but half the optimum height is assessed at 75% of the optimum under the vigour score criteria. That is, an average is taken of the linear measurements. This approach simplifies field ratings.

No stem dimensions are used in the method, because of the difficulty of rapid measurement and the need to embrace multi-stemmed trees, shrubs and ground-cover plants in the assessment. The need for observers to have prior knowledge of species characteristics seemed desirable, if not essential, so this requirement was tested using a student from Roseworthy Agricultural College who was inexperienced in plant assessment.

The method was first used at the Monarto Irrigation Experiment Station near Murray Bridge (35° 10′S 139° 17′E) and later at the Arid Zone towns of Woomera, (31° 11′S 136° 54′E), Leigh Creek (30° 31′S 138° 25′E) and Radium Hill (32° 30′S 140° 32′E), South Australia. At Monarto it proved effective in distinguishing the effects of irrigation treatments and soil type on trees, shrubs and groundcovers (Lay, 1980). In this example, scores were averaged for all 46 species to give relative plant performance.

Statistical analysis

The analysis used data from field tests at Monarto and Woomera. The data consisted of four sets of observations. These were (1) Two trained observers; one experienced in plant assessment, the other relatively inexperienced, independently assessed 460 trees and shrubs at Monarto in March 1980. (2) An experienced observer rated 46 plants at Monarto in July 1982 and repeated it a week later. (3) A set of observations (992) was taken in May 1983 by an experienced observer followed a month later by an inexperienced observer. (4) Three trained observers rated a group of trees, either singly or as a clump (27 observations) at Woomera in November 1982. In each case the observers independently scored individual plants on the health and vigour scale as outlined in Table 1.

Contingency tables of agreement between observers were drawn up from the health and vigour scores (see Appendix). The method of analysis tested whether observers were ranking the plants similarly. If the observers agreed on the ranking then the tables would be symmetrical, but if they disagreed then non-symmetrical tables would result. The tables were said

to be quasi-symmetrical if all the values for a particular row were a multiple of the corresponding column. (Bishop, Fienberg and Holland, 1975). That is, observers applied a constant bias to each category independent of each other. A significant test value (chi-squared) indicated this condition. If this was not so, then the tables were tested for overall symmetry which was indicated by a non-significant test value. If the tables were symmetrical overall then this implied that the row and column totals were also equal (marginal homogeneity).

Table 2. Results of statistical analyses for data sets 1-4. Figures are chi-squared values.

Data set		Health		Vigour	
1	Quasi-symmetry	4.828	n.s.	2.241	n.s.
	Symmetry	29.41	*	8.823	n.s.
	Marg. Homegeneity	24.58	***	6.582	n.s.
2	Quasi-symmetry	0.0003	n.s.	0.0003	n.s.
	Symmetry	4.271	n.s.	14.29	n.s.
	Marg. Homogeneity	4.271	n.s.	14.29	n.s.
3	Quasi-symmetry	20.47	*	27.41	***
4	Quasi-symmetry	10.03	*	0.0002	n.s.
obs.	Symmetry	—		4.159	n.s.
1 vs 2	Marg. Homogeneity	—		4.159	n.s.
	Quasi-symmetry	0.0001	n.s.	0.0001	n.s.
obs.	Symmetry	7.070	n.s.	12.68	*
1 vs 3	Marg. Homogeneity	7.070	n.s.	12.68	**
	Quasi-symmetry	0.0001	n.s.	0.0001	n.s.
obs.	Symmetry	12.82	*	12.14	n.s.
2 vs 3	Marg. Homogeneity	12.82	**	12.14	**

n.s. Not significant; * Significant at 5% level
** Significant at 1% level; *** Significant at 0.1% level

Results and discussion

(a) Data analyses

The data sets are presented as contingency tables of health and vigour scores in the Appendix. Results of the statistical analyses are shown in Table 2. The tables were symmetrical for both health and vigour only for data set 2 (self-consistency test) i.e. the observer was consistent in his rating ability even though a week had elapsed between observations. Observer bias was indicated by the significant chi-squared value for data set 3 (inexperienced observer) where the model of quasi-symmetry was rejected for both health and vigour. This may have been due to some mis-identification of plants by the Roseworthy student as indicated by the ratings of 4 and 5 against ratings of 0 and 1 by the other observer and vice versa in the table. The results for data set 4 were variable possibly because of the low total numbers of observations.

The statistical evaluation does highlight several matters in regard to the method. Firstly, over a short time span an observer can consistently give an equal rating to the same set of plants. Hence, there should be little difference in day to day ratings when assessing large amenity plantings. Secondly, any method of visual assessment, no matter how inherently

objective it is, requires training of the observers. This is shown particularly by the results of the inexperienced Roseworthy student (data set 3) and to a lesser extent by the tables which displayed asymmetry. Discrepancies in ratings will always occur between observers because of their different perceptive abilities and the weight each of them places on the method's criteria. It is therefore essential for observers to spend time together on calibration and where possible, to statistically analyse the observations taken to check for bias. The calibration should cover the full range of the rating scale.

The analyses overall indicate that criteria derived for distinguishing between the different scores can lead to objective assessment of plants whether they are trees, shrubs or groundcover. This contention is further borne out if the degree of agreement between observers is considered. Complete agreement amongst observers, (the sum of the main diagonal of the table), ranged from 44% (data set 4, observer 1 vs observer 2, health) to 79% (data set 1, health). The diagonals on either side of the main one represent a difference in rating of one point between observers. The sum of these "one-off" values plus the values for complete agreement, ranged from 89% (data set 3, vigour) to 100%. Hence, even though there was significant observer bias in some instances, they agreed within one point of each other in more than 90% of cases.

(b) Practical applications

The method was developed to determine the relative performance of a range of plants at a given locality or under different cultural conditions. The individual scores for the two categories can be used in two ways. Firstly, where the aim of the exercise is to provide a ranked performance summary, then all that is required is the overall rating value, produced by summing the individual health and vigour assessments. Averaging the individual ratings for each species can then provide an average performance score on a 10 point scale. This score can then provide a basis for simple and commonly accepted performance categories according to the following table:

Average rating (Health + vigour)	Performance Category
8 - 10	Satisfactory/recommended
6 - 7	Indeterminate
0 - 5	Poor/not recommended

This method has proved adaptable and for most evaluations of plantings the above divisions have been satisfactory. The method was used recently by Bulman (1983) and Lay (1980, 1983). Moreover it is obvious that the more harsh the site is, the lower the admissible performance scores for recommended species.

Secondly, if a more detailed analysis of environmental or treatment effects on growth is required, then it is not desirable to combine the individual health and vigour scores in an overall rating value. For example, variation in performance of some plants may be due to different growth rates or to different degress of susceptibility to leaf-chewing insects. There is a need under some circumstances, e.g. provenance trials, to evaluate factors affecting performance of a taxon at a specific or even subspecific level. It is more important for amenity purposes that a plant looks healthy though it may grow slowly, than a faster growing specimen which looks unhealthy much of the time due to damage or disease.

The main limitation of the method as an objective and scientific approach to plant assessment is that observers need to know potential growth rates and final sizes of species. In practice, however, this limitation is not as serious as it may first appear for the following reasons:

a) Final size of most species under cultivation can be obtained from published works or from observations of old established plantings. These sizes can be recorded and referred to in the field.

b) The vigour scales are not sensitive to large differences in expected optimal growth as perceived by different observers. As can be seen from Table 1 the vigour criteria uses the average of the linear measurements (height and canopy dimensions). If the optimal height and canopy dimensions as perceived by one observer are half of those as discerned by another, a difference in one point arises. Hence a large variation between observers in expected growth will only have a small effect on the overall rating given.

c) Many amenity surveys require relative performance of different taxa at a site or between different sites and so absolute values are not important.

Errors are more likely to occur in young plantings where less information is usually available to both experienced and inexperienced observers on a growth-for-age basis. However, any performance figures must be considered tentative only where plantings are young (see comments in Lay, 1983). It is the relative performance of taxa in these young plantings which is more important.

Conclusions

This objective approach to the evaluation of amenity plantings provides a statistically repeatable basis for determining the subjective concept of amenity value. We believe that it can provide a meaningful and objective basis to the assessment of horticultural performance of various plant taxa. In addition, when incorporated with other criteria, it can also be used to more objectively define monetary value of individual plant specimens.

Acknowledgements

We are grateful for the considerable time spent by our observers and colleagues in developing the method and survey work—Mr B. Dubois and Mr E. Thexton at Monarto and Mr A. Beal and Mr J. Zwar at Woomera. We also thank Mr P. McCloud for statistical advice on the analysis of contingency tables.

References

Australian Institute of Horticulture (1977). A method for assessing the monetary value of trees used in amenity horticulture. "Technical memorandum No. 1", July 1977, 14pp.

Bishop, Y.M.M., Fienberg, S.E. and Holland, P.W. (1975). Analysis of Square Tables: Symmetry and Marginal Homogeneity pp 281-310 In "Discrete Multivariate Analysis: Theory and Practice". (M.I.T. Press: Cambridge, U.S.A.).

Boomsma, C.D. (1973). The Monetary Value of Amenity Trees in Public Places. *Australian Parks* 36-39.

Bulman, P.U. (1983). Broadscale Planting Techniques and Species evaluation at Monarto. "S.G.A.P. Seminar papers, Lincoln College". (S.G.A.P.: Adelaide).

Good, J.E., Craigie, I., Last, F.T. and Munro, R.C. (1978). Conservation of Amenity Trees in the Lothian Region of Scotland. *Biological Conservation* 13 (4) 247-272.

Kartzoff, O.A.M. (1977). Amenity tree valuation for Australia. *Institute of Foresters of Australia, Newsletter.* 18 (3): 24-27.

Lay, B.G. (1980). Assessment of Amenity Tree planting on the Monarto Irrigation Experiment Station. "South Australian Department of Agriculture, Soil Conservation Branch Report S7/80", 15pp.

Lay, B.G. (1983). Effects of Irrigation Regimes on Performance of Native Plants Under Cultivation pp 31-43 In "Biology of Native Plants Under Cultivation". (South Australian Department of Environment and Planning: Adelaide).

Raad, A. (1972). The Value of Trees. *Australian Parks* 8 (4) 507.

Wycherley, P.R. (1979). Amenity Tree Valuation—A Working Paper. *Supplement to Australian Parks and Recreation*, 15, 9 pp.

Appendix

Data set 1

Health — Observer 1

	Scores	0	1	2	3	4	5	Marg. total
Observer 2	0	30	1	0	0	0	0	31
	1	0	10	2	0	0	0	12
	2	0	4	8	3	1	0	16
	3	0	3	3	37	9	0	52
	4	0	0	1	25	71	49	146
	5	0	0	0	2	20	181	203
Marg. Total		30	18	14	67	101	230	460

Vigour — Observer 1

	Scores	0	1	2	3	4	5	Marg. total
Observer 2	0	30	1	0	0	0	0	31
	1	0	31	4	1	0	0	36
	2	0	6	30	20	1	0	57
	3	0	0	19	53	20	1	93
	4	0	0	2	20	92	26	140
	5	0	0	0	1	12	90	103
Marg. Total		30	38	55	95	125	117	460

Data set 2

Health — Observer 1

	Scores	0	1	2	3	4	5	Marg. total
Observer 2	0	3	0	0	0	0	0	3
	1	0	1	2	0	0	0	3
	2	0	0	0	1	0	0	1
	3	0	0	0	4	1	0	5
	4	0	0	0	1	3	4	8
	5	0	0	0	0	5	21	26
Marg. Total		3	1	2	6	8	25	46

Vigour — Observer 1

	Scores	0	1	2	3	4	5	Marg. total
Observer 2	0	3	0	0	0	0	0	3
	1	0	2	0	0	0	0	2
	2	0	3	0	1	0	0	4
	3	0	0	1	2	2	0	5
	4	0	0	0	0	4	9	13
	5	0	0	0	0	1	18	19
		3	5	1	3	7	27	46

Data set 3

Health — Observer 1

	Scores	0	1	2	3	4	5	Marg. Total
Observer 2	0	182	0	0	1	1	2	186
	1	0	5	13	2	0	4	24
	2	0	4	35	15	8	5	67
	3	0	7	17	38	41	11	114
	4	0	3	12	49	113	94	271
	5	2	0	4	22	109	193	330
Marg. Total		184	19	81	127	272	309	992

Vigour — Observer 1

	Scores	0	1	2	3	4	5	Marg. Total
Observer 2	0	182	0	0	0	2	2	186
	1	1	14	30	11	6	3	65
	2	1	0	33	23	13	11	81
	3	0	0	33	80	50	20	183
	4	0	0	9	68	120	42	239
	5	0	1	4	26	101	106	238
Marg. Total		184	15	109	208	292	184	992

Data set 4

Health Observer 1

	Scores	(0,1,2)	3	4	5	Marg. Total
Observer 2	(0,1,2)	1	0	1	0	2
	3	4	4	0	0	8
	4	0	6	2	0	8
	5	0	0	4	5	9
Marg. Total		5	10	7	5	27

Health Observer 1

	Scores	(0,1,2)	3	4	5	Marg. Total
Observer 3	(0,1,2)	5	2	1	0	8
	3	0	3	1	0	4
	4	0	5	3	2	10
	5	0	0	2	3	5
Marg. Total		5	10	7	5	27

Health Observer 2

	Scores	(0,1,2)	3	4	5	Marg. Total
Observer 3	(0,1,2)	2	5	1	0	8
	3	0	2	2	0	4
	4	0	1	6	3	10
	5	0	0	0	5	5
Marg. Total		2	8	9	8	27

Vigour Observer 1

	Scores	(0,1,2)	3	4	5	Marg. Total
Observer 2	(0,1,2)	1	2	0	0	3
	3	0	7	1	0	8
	4	0	3	7	1	11
	5	0	0	2	3	5
Marg. Total		1	12	10	4	27

Vigour Observer 1

	Scores	(0,1,2)	3	4	5	Marg. Total
Observer 3	(0,1,2)	3	5	1	0	9
	3	0	1	3	0	4
	4	0	2	7	3	12
	5	0	0	0	2	2
Marg. Total		3	8	11	5	27

Vigour Observer 2

	Scores	(0,1,2)	3	4	5	Marg. Total
Observer 3	(0,1,2)	1	8	0	0	9
	3	0	3	1	0	4
	4	0	1	8	3	12
	5	0	0	1	1	2
Marg. Total		1	12	10	4	27

J. Adelaide Bot. Gard. 7(2): 167-179 (1985)

THE PERFORMANCE OF AN AMENITY PLANTING UNDER IRRIGATION AT MONARTO, SOUTH AUSTRALIA

Anthony P. Meissner and Brendan G. Lay

S.A. Department of Agriculture, 25 Grenfell Street, Adelaide, South Australia, 5000.

Abstract

An extensive trial of forty six tree, shrub and groundcover species under various irrigation regimes and natural rainfall was used to evaluate the performance of these plants for amenity purposes. Multivariate cluster analysis was used to separate the plants into groups on overall performance under all the irrigation regimes. Nearly half of the species used grew satisfactorily under all test conditions. These plants came from areas in southern Australia which received between 350 and 500mm of annual rainfall and are tolerant of a range of acid and alkaline soils. All exotic plants in the trial performed poorly and most eventually died. Plants irrigated at the optimum rate performed best.

Introduction

The cultivation of trees, shrubs and ground cover plants specifically for the amelioration of the urban environment is accepted practice throughout the world and an integral part of town planning. In recent years there has been a greater appreciation of Australian native flora for amenity plantings. There is, however, a general misconception that native plants will thrive under all environmental conditions. Hence, the selection of native species is often in the absence of information about the local environment, the plant's own natural habitat, or its performance in similar situations elsewhere.

As specific information of plant performance under different climatic or cultural conditions is lacking, it is often difficult to recommend a range of plants for cultivation in a specific location. Little data are available on the effects of irrigation rate or method and its relationship to soil type. This is possibly because these plantings have no economic value *per se* even though it is necessary to select the right tree, shrub or ground cover species to plant.

In the early 1970's, the Government of South Australia proposed to build a new city at Monarto near Murray Bridge (35° 10'S 139° 17'E). Investigations of the soils and hydrology of the site indicated the likelihood of high soil salinity and ground water tables developing as a result of increased water application following urbanization (Schrale 1976). The Department of Agriculture collaborated with the Monarto Development Commission to evaluate the probable effects of irrigation practices in an urban environment on soil salinity, groundwater hydrology and the performance of a range of commonly grown amenity plants. The Monarto Irrigation Experiment Station was therefore established in 1976.

Overall performance of these plantings has been described in a general way by Lay (1980, 1983). This paper reports the statistical evaluation of these results and describes the effects of the different irrigation treatments on the growth of the plants.

Design of experiment

Details of the site and irrigation design are given in Schrale (1976) and Dubois (1977). Briefly, nine beds were laid out as shown in Figure 1. Eight of the beds were planted with a range of trees, shrubs and ground-covers, the ninth contained only mown grass. Each of the eight planted beds was further subdivided into three sub-beds and planted with forty six native and exotic species (Figure 2). Table 1 lists the species together with their tolerance to some soil conditions and the minimum average annual rainfall of areas of their natural occurence.

The treatments applied were (1) natural rainfall, (2) drip irrigation applied at the calculated

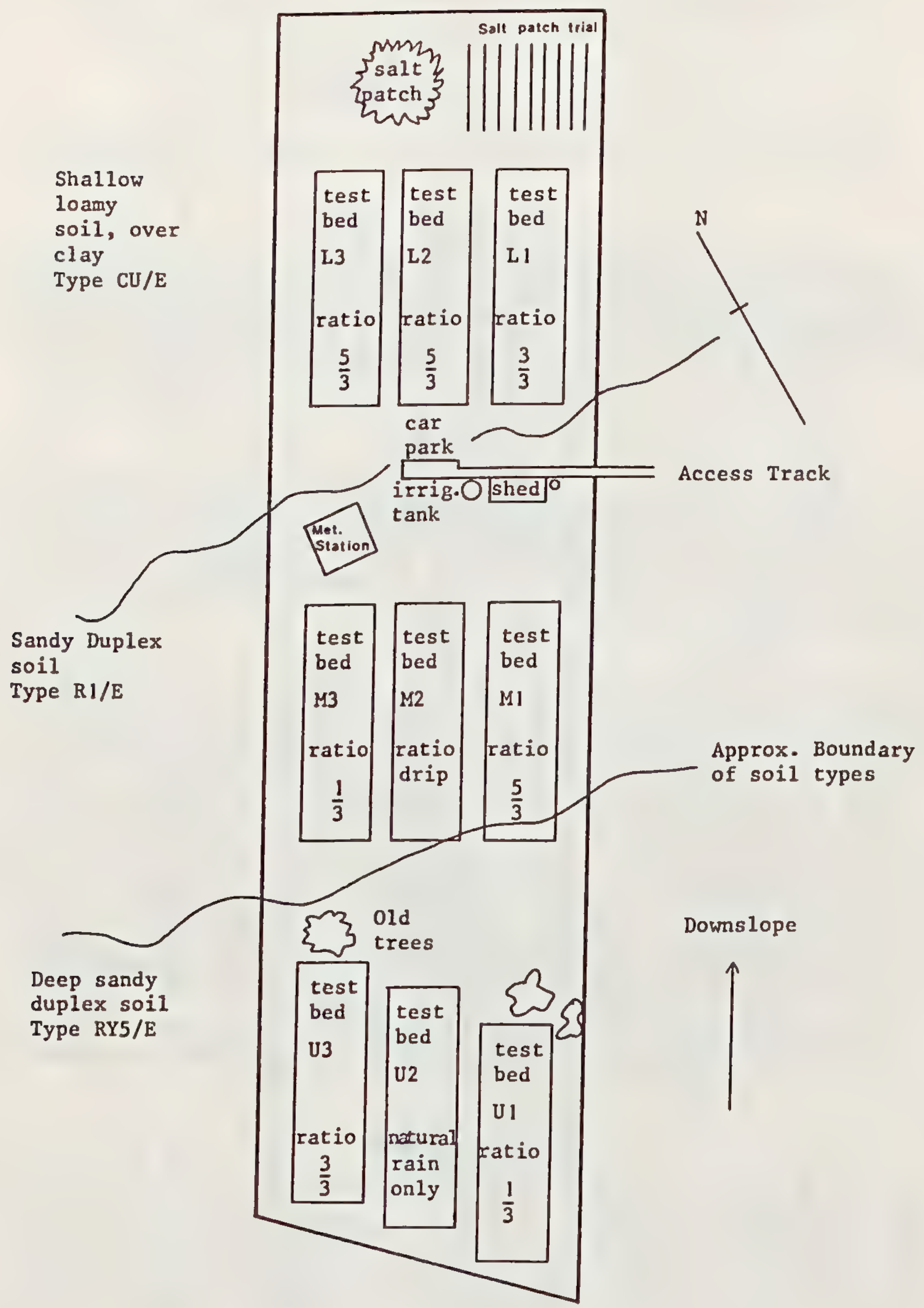
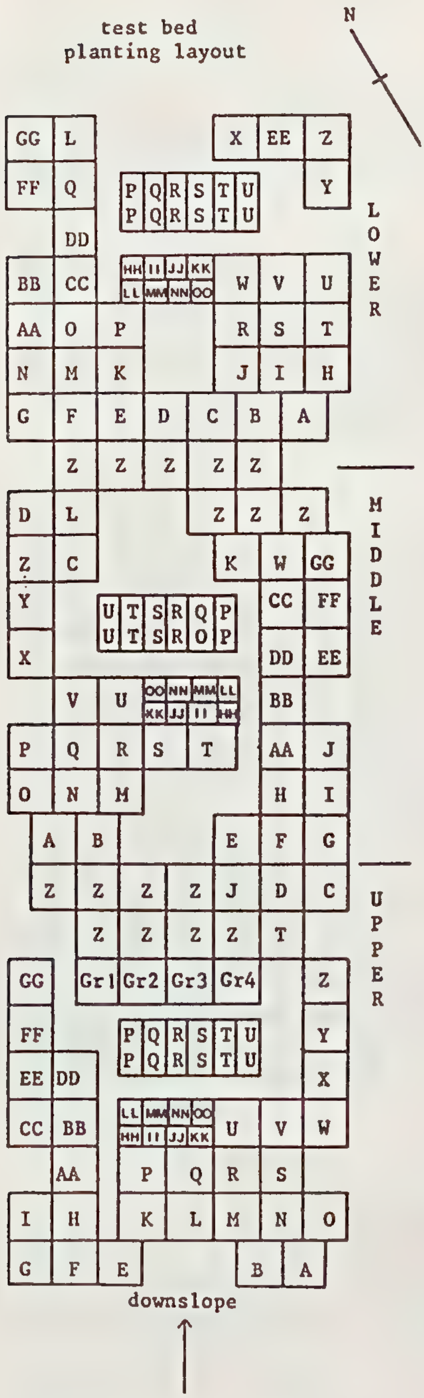


Fig. 1. Site layout details for the experimental site. Soil types refer to the Factual Key (Northcote, 1970).



	Plant species
A	*Eucalyptus odorata* Schltdl.
B	*Eucalyptus salmonophloia* F. Muell.
C	*Eucalyptus ficifolia* F. Muell.
D	*Eucalyptus gomphocephela* A. Dc.
E	*Eucalyptus redunca* Schauer. var. *melanophloia* Benth.
F	*Eucalyptus melliodora* Schauer
G	*Eucalyptus leucoxylon* F. Muell. var. *rosea*
H	*Eucalyptus maculata* Hook.
I	*Eucalyptus sideroxylon* Woolls.
J	*Casuarina cunninghamiana* Mig.
K	*Acacia calamifolia* Sweet ex Lindl.
L	*Acacia iteaphylla* F. Muell. ex Benth.
M	*Acacia pendula* G. Don
N	*Acacia brachybotrya* Benth.
O	*Acacia saligna* (Labill.) H. Wendl.
P	*Agonis flexuosa* (Spreng.) Schauer
Q	*Callistemon salignus* (Sm.) DC.
R	Callistemon viminalis (Gaertn.) Loud.
S	*Hakea elliptica* (Sm.) R. Br.
T	*Eucalyptus forrestiana* Diels
U	*Hakea laurina* R. Br.
V	*Eucalyptus spathulata* Hook.
W	*Leptospermum laevigatum* (Gaertn.) F. Muell.
X	*Melaleuca armillaris* Sm.
Y	*Melaleuca halmaturorum* Mig.
Z	*Melaleuca nesophila* F. Muell.
AA	*Celtis occidentalis* L.
BB	*Bougainvillea magnifica* var. *traillii*
CC	*Lagerstroemia indica* L.
DD	*Brachychiton populneo/acerifolium*
EE	*Hibiscus* "General Cortegis"
FF	*Jacaranda mimosifolia* D. Don
GG	*Melia azedarach* L.
HH	*Cassia nemophila* J.R.T. Vogel
II	*Calocephalus brownii* F. Muell.
JJ	*Calothamnus quadrifidus* F. Br.
KK	*Eremophila maculata* (Ker.) F. Muell.
LL	*Grevillea rosmarinifolia* Cunn.
MM	*Hakea suaveolens* R. Br.
NN	*Melaleuca decussata* R. Br.
OO	*Templetonia retusa* (Vent.) R. Br.
PP	*Enchylaena tomentosa* R. Br.
QQ	*Hardenbergia comptoniana* (Andr.) Benth.
RR	*Eremophila glabra* (R. Br.) Ostenf.
SS	*Myoporum parvifolium* R. Br.
UU	*Rhagodia spinescens* R. Br.

Fig. 2. Planting layout of each test bed.

rate of potential plant water use under drip**, (3) sprinkler irrigation applied at the calculated potential plant water use (designated as ratio 3/3 in Figure 1), (4) sprinkler irrigation at five thirds (5/3). The total water applied by dripper was one third the sprinkler rate. The layout of the treatments is shown in Figure 1. The experiment began in April 1977 and irrigations ceased in June 1982. Plants which died or were damaged by equipment were replanted only until March 1978. Daily rainfall was recorded at the site from September, 1976 to August, 1982. Annual rainfall during the experiment averaged 336 mm and annual totals for 1977 to 1981 were 313, 385, 382, 317 and 322 mm. Photograph 1 shows a view over the lower and middle test beds at the end of the experiment.

Plants were chosen on the basis of species commonly available to the public and included some known for their salt tolerance. In particular, South Australian dryland and coastal species were chosen where possible (Matheson and Barwick, 1975).

The performance of the plants was evaluated on three occasions: March 1980, July 1982 and May 1983. The method of assessment used is described by Lay and Meissner (1985); each plant was rated individually on a six point scale for health and vigour.

Data analyses

As the experiment was not completely replicated conventional statistical analysis was not appropriate. The approach adopted was to use multivariate cluster analysis techniques to derive species performance groupings and to elucidate the effects of irrigation and time on plant performance. The data set contained 39,744 items made up of 46 species x 3 sub-beds x 8 beds x 3 times for each of 6 health and vigour categories.

These data were reduced to derive the species performance groupings. Contingency tables of species x health and vigour categories were drawn up for each of the three dates on which the plantings were assessed. For example, a health table had 46 rows, one for each species and six columns, one for each point of the health scale. This gave six tables of 6 columns each. These columns were then considered as 36 variables, each column (variable) containing the number of occurrences a species was assessed as having a particular health or vigour score at one of the times of assessment. A similarity matrix of performance between species was calculated using a linear quantitative measure (Gower, 1971). This similarity matrix was then used as the basis for hierarchical cluster analysis using the furthest neighbour technique. Groups were delineated by visual inspection of the resulting dendrogram. The treatment x time effect groups were derived similarly by reducing the original data set by amalgamating over species and sub-beds. The GENSTAT statistical package was used to carry out the data manupulations and analyses (Alvey *et al.* (1977)).

Results and discussion

The hierarchical nature of the analysis and the resulting dendrogram do not imply any inherent relationship between plant species or groups, but should be seen only in the context of separating plants into similar groups on their response to a particular set of environmental conditions.

**Determination of average plant water requirement was done according to Schrale (1976). He used the potential evapotranspiration from a mown, well-watered grass as a guide for the first two years. After this time, plant requirement was determined from tree lysimeter studies and included a provision that about 15% of applied water was available to leach salts beyond the root zone of the plants.

Table 1 **Species used in Monarto irrigation experiment**

Symbol	Botanical name	Common name	Native to	Height	Rainfall mm	ACF
A	Eucalyptus odorata	Peppermint Box	Monarto	6-8	450	AC
B	Eucalyptus salmonophloia	Salmon Gum	W.A.	10-15	350	C
C	Eucalyptus ficifolia	Red Flowering Gum	W.A.	6-8	550	A
D	Eucalyptus gomphocephala	Tuart	W.A.	10-30	450	ACF
E	Eucalyptus redunca v. melanophloia	Black Barked Marlock	W.A.	3-5	400	AC
F	Eucalyptus melliodora	Yellow Box	Vic.	10-20	500	
G	Eucalyptus leucoxylon rosea	Red Flowered S.A. Blue	Monarto	8-20	500	AC
H	Eucalyptus maculata	Spotted Gum	N.S.W.	8-25	600	A
I	Eucalyptus sideroxylon	Red Ironbark	S.A.	10-20	500	AC
J.	Casuarina cunninghamiana	River Oak	Qld.	10-25	550	AC
K	Acacia calamifolia	Wallowa	S.A.	2-5	250	C
L	Acacia iteaphylla	Flinders Range Wattle	S.A.	3-5	400	AC
M	Acacia pendula	Weeping Myall	S.A.	6	400	AC
N	Acacia brachybotrya	Grey Mulga	Monarto	2	350	AC
O	Acacia saligna	Golden Wreath Wattle	S.A.	6	450	ACF
P	Agonis flexuosa	Willow Myrtle	W.A.	5-8	500	ACF
Q	Callistemon salignus		S.A.	3-5	500	A
R	Callistemon viminalis	Weeping Bottlebrush	N.S.W.	4-6	550	A
S	Hakea elliptica		W.A.	2-5	330+	AC
T	Eucalyptus forrestiana	Fuchsia Gum	W.A.	3-5	350	AC
U	Hakea laurina	Pincushion Hakea	W.A.	3-5	450	ACF
V	Eucalyptus spathulata	Swamp Mallet	W.A.	6-8	400	ACS
W	Leptospermum laevigatum	Coastal Teatree	Vic.	2-4	400	ACF
X	Melaleuca armillaris	Bracelet Honey Myrtle	Vic.	3-5	450	
Y	Melaleuca halmaturorum	K.I. Swamp Paperback	S.A.	2-4	350	ACS
Z	Melaleuca nesophila	Western Honey Myrtle	W.A.	2-3	450	ACF
AA	Celtis occidentalis	Hackberry	Exotic	10-15	450	
BB	Bougainvillea magnifica var. traillii	Purple Bougainvillea	Exotic	2-3	500	
CC	Lagerstroemia indica	Crepe Myrtle	Exotic	3-4	450	F
DD	Brachychiton populneo/acerifolium	Hybrid Flame Tree	N.S.W.	10-15	500	AC
EE	Hibiscus "General Cortegis"	Hibiscus	Exotic	1-2	550	
FF	Jacaranda mimosifolia	Jacaranda	Exotic	6-10	550	
GG	Melia azedarach	White cedar	Qld.	6-10	500	AC
HH	Cassia nemophila var.	Desert Cassia	S.A.	1-2	250	AC
II	Calocephalus brownii	Cushion Bush	S.A.	½	400	ACF
JJ	Calothamnus quadrifidus	Crimson Net Bush	W.A.	2-3	500	A
KK	Eremophila maculata	Spotted Emu Bush	Monarto	1-2	350	C
LL	Grevillea rosmarinifolia	Rosemary Grevillea	Vic.	2-3	550	A
MM	Hakea suaveolens	Sweet Hakea	W.A.	3-4	350	ACF
NN	Melaleuca decussata	Crossleaved Honey Myrtle	S.A.	1-3	450	ACS
OO	Templetonia retusa	Red Templetonia	S.A.	1-2	400	C
PP	Enchylaena tomentosa	Ruby Saltbush	Monarto	GC	300	C
QQ	Hardenbergia comptoniana	W.A. Coral Pea	W.A.	GC	600	ACS
RR	Eremophila glabra	Tar Bush	S.A.	GC	350	CS
SS	Myoporum parvifolium	Creeping Boobialla	S.A.	GC	500	ACSF
UU	Rhagodia spinescens		S.A.	GC	300	CS

* Considered tolerant of:
A = Acid neutral soils; C = Calcareous (alkaline) soils;
F = Coastal sites; S = Saline sites

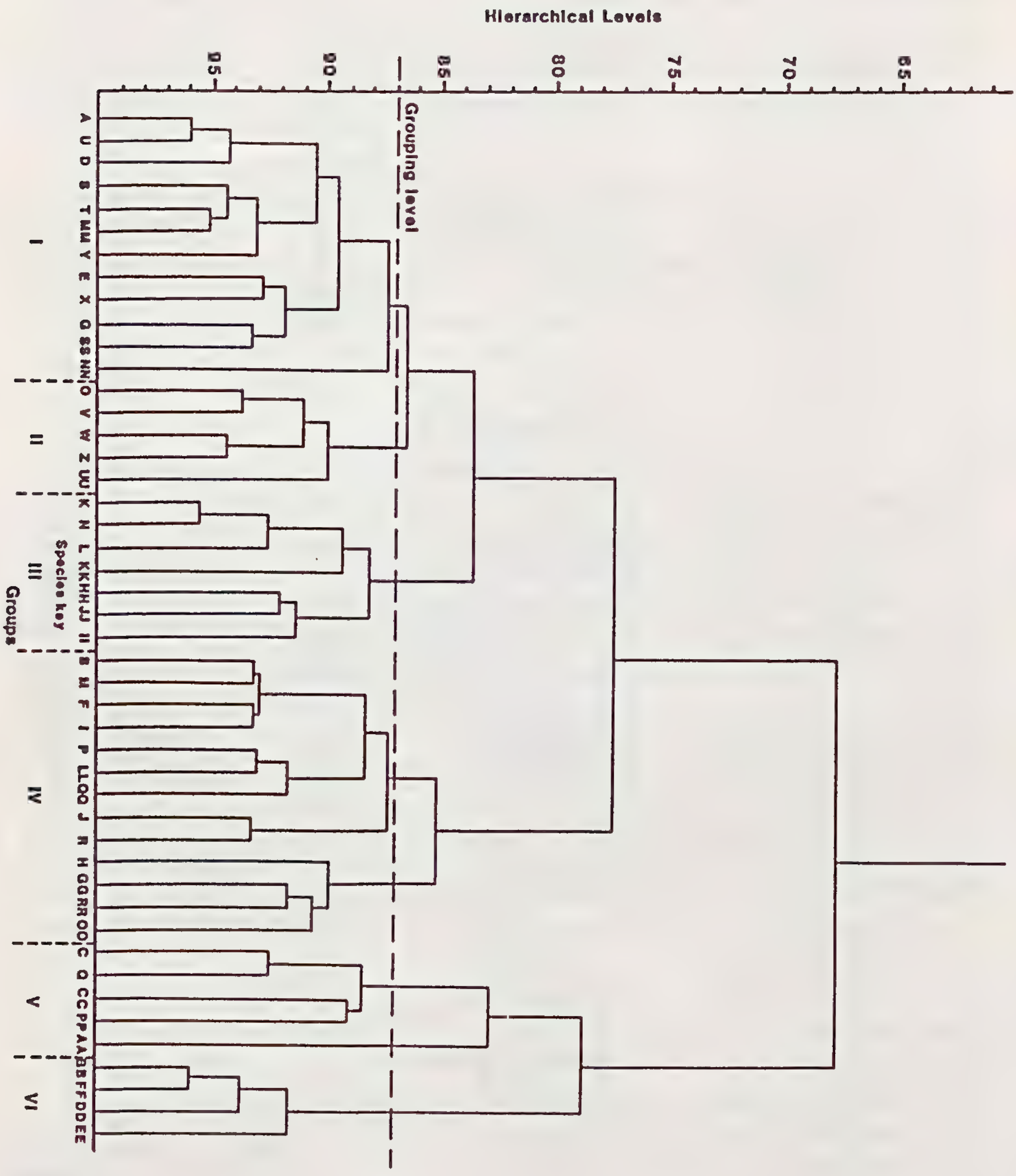


Fig. 3. Dendrogram of cluster analysis for species performance. Letters refer to species (see Table 1) and roman numerals to groups.

Table 2. Health and vigour profiles for typical members of each group. Righthand column of figures are mean performance scores from Lay (1983). A rating of 0 for health and vigour indicate a dead plant while a score of 5 indicates a healthy or vigorous plant. (Lay and Meissner, 1985).

Group	Species	Time	Health 0	1	2	3	4	5	Vigour 0	1	2	3	4	5	Perform. Scores
I	*Hakea elliptica*	March 1980	0	0	0	0	5	19	0	0	0	5	7	12	9.6
		July 1982	0	0	0	1	8	15	0	0	1	6	10	7	8.5
		May 1983	0	2	1	4	7	10	0	1	1	8	9	5	7.6
II	*Eucalyptus spathulata*	March 1980	1	0	0	1	8	14	1	0	2	0	8	13	8.7
		July 1982	1	0	0	1	2	20	1	0	0	2	4	17	9.0
		May 1983	2	0	1	0	0	21	2	2	0	2	4	14	8.4
III	*Cassia nemophila*	March 1980	1	0	2	3	5	12	1	1	2	7	11	2	7.6
		July 1982	5	1	2	3	7	6	5	0	2	2	8	7	6.2
		May 1983	9	0	3	1	8	3	9	1	1	3	6	4	4.7
IV	*Templetonia retusa*	March 1980	1	1	0	7	8	7	1	1	6	3	6	7	7.7
		July 1982	3	1	5	10	4	1	3	2	4	8	6	1	5.2
		May 1983	3	0	1	8	12	0	3	2	4	8	7	0	5.7
V	*Eucalyptus ficifolia*	March 1980	2	2	1	10	5	4	2	5	6	7	3	1	5.9
		July 1982	7	0	2	8	7	0	7	6	5	2	3	1	4.0
		May 1983	8	0	1	6	7	2	8	3	3	4	5	1	3.6
VI	*Brachychiton populneo-acerfolium*	March 1980	4	6	2	7	5	0	4	13	5	2	0	0	3.8
		July 1982	18	5	1	0	0	0	18	5	1	0	0	0	0.6
		May 1983	23	1	0	0	0	0	23	1	0	0	0	0	0.1

(a) Species performance groups

Six performance groups were delineated. The dendrogram derived by using furthest neighbour cluster analysis is shown in Figure 3. Groups I to IV were separated from Groups V and VI on the basis of the number of plants that died (0 score for both health and vigour). The number of species in each group were 12, 5, 7, 13, 5 and 4 for groups I and VI in that order. Mean values within group similarities ranged from 91.7% (Group I) to 88.7% (Group VI) with Groups I and II most similar (90.1%). Groups I and VI were most dissimilar (70.9%). Group I and II plants were generally healthy and grew vigorously over the duration of the experiment. Group II plants generally became more healthy and vigorous with time even though there were some deaths. Species in Group VI rapidly declined in health and vigour over the course of the experiment and these consisted exclusively of exotic plants. The performance profile of typical members of each group is shown in Table 2.

The performance of plants in all groups except Group II declined with time. The best performing groups were species that all came from areas receiving between 350 and 500 mm of average annual rainfall and tolerant of both acid and alkaline soils with some plants known to be salt tolerant. Group IV plants were generally from high rainfall areas and not tolerant of alkaline soils. Species in Groups I and II performed well over all irrigation treatments and continued to do so even when irrigation ceased in July 1982. This was despite the severe drought which occurred in that year. This group of plants can be expected to perform similarly in environments like that at the Monarto site. Even though Group VI plants are widely grown with success in some urban environments in South Australia this group could not be recommended in drier areas if irrigation is discontinued after establishment or where salinity or high water tables may occur.

Slightly different groupings may have been obtained with other methods of constructing the similarity matrix or the use of other clustering techniques such as nearest neighbour or centroid

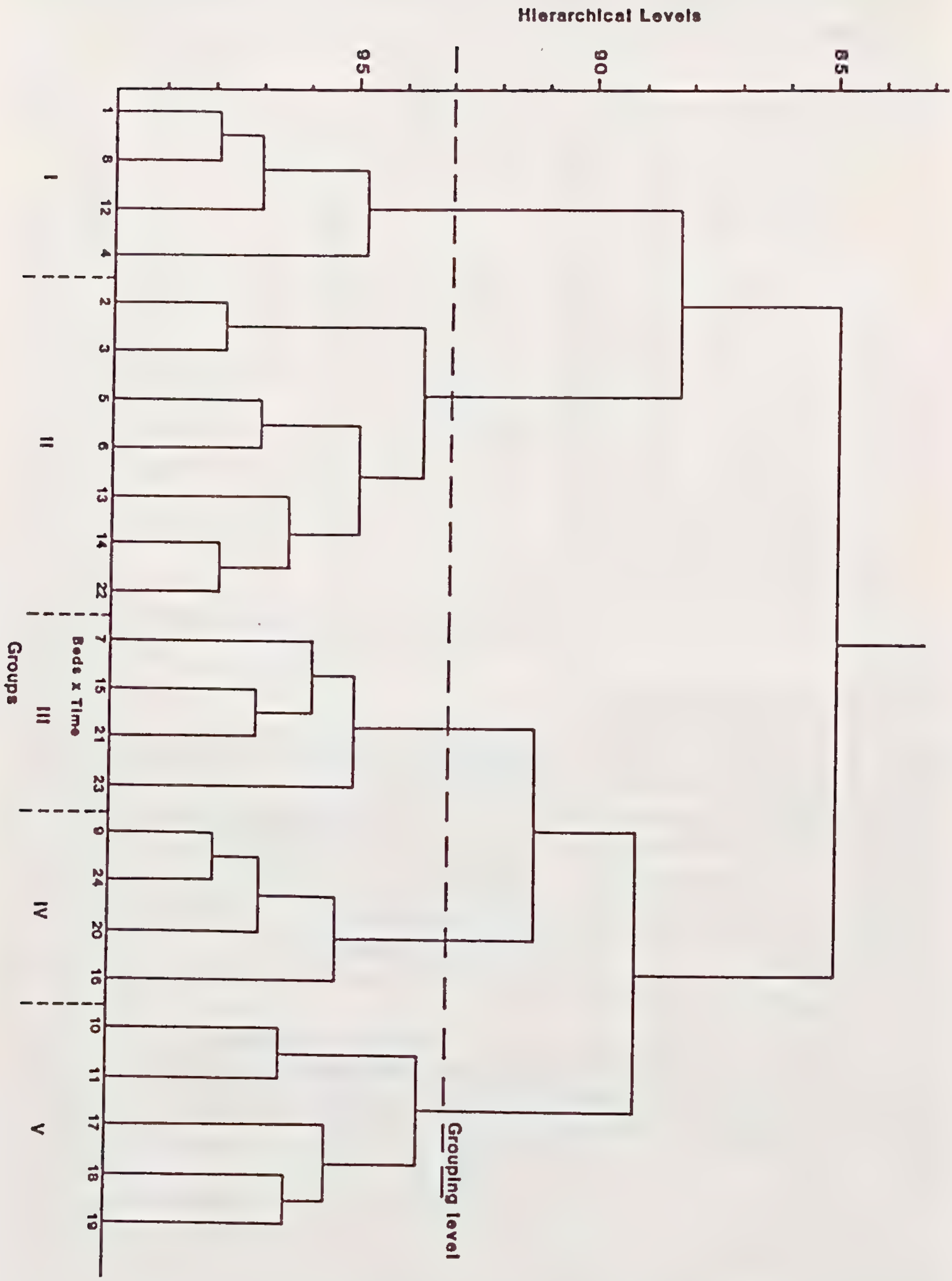


Fig. 4. Dendrogram of cluster analysis for irrigation treatments and time of evaluation. Key to numbers is given in Table 3.

Table 3. Key to numbers on the dendrogram in Figure 4.

Key	Group	Bed		Treatment	Time
1	I	Lower	1	3/3	March 1980
8		Upper	3	3/3	March 1980
4		Middle	2	Drip	March 1980
12		Middle	2	Drip	July 1982
2	II	Lower	3	5/3	March 1980
3		Middle	1	5/3	March 1980
5		Middle	3	1/3	March 1980
6		Upper	1	1/3	March 1980
13		Middle	3	1/3	July 1982
14		Upper	1	1/3	July 1982
22		Upper	1	1/3	May 1983
7	III	Upper	2	Rain	March 1980
15		Upper	2	Rain	July 1982
23		Upper	2	Rain	May 1983
21		Middle	3	1/3	May 1983
9	IV	Lower	1	3/3	July 1982
16		Upper	3	3/3	July 1982
20		Middle	2	Drip	May 1983
24		Upper	3	3/3	May 1983
10	V	Lower	3	5/3	July 1982
11		Middle	1	5/3	July 1982
17		Lower	1	3/3	May 1983
18		Lower	3	5/3	May 1983
19		Middle	3	5/3	May 1983

clustering. Clustering techniques can summarize data efficiently and show the subtle differences which give rise to the groupings. Table 2 shows the differences in the health and vigour categories for examples from the groups. If the facilities for multivariate cluster analyses are not available, groups can be derived by averaging the sum of the health and vigour scores over all treatments as described by Lay (1983) and Lay and Meissner (1985). These mean figures are shown in Table 2 for comparison with the multivariate analysis groups.

(b) Irrigation treatments and time effects

Results of the cluster analysis are shown as a dendrogram in Figure 4. The key to the number is shown in Table 3. Five groups were delineated at the 93% heirarchical level. The groupings indicate some interaction between the irrigation treatments and time. This can be seen from Table 3 where the irrigation and time treatment are shown in their derived groups. The effect of optimum irrigation treatments early in the experiment is characteristic of Group I members. In contrast Group IV members were associated with the later effects of the optimum irrigation rate. Plants which were in the optimum groups were generally healthier and grew more vigorously than those in the other clusters. Sub-optimal irrigation effects over the duration of the experiment separated out in Group II. This group was, predictably, most similar to Group III consisting mostly of the natural rainfall treatment. The under-watered groups (rain and 1/3 irrigation) were healthy but did not grow as quickly. Overwatering effects at the later stages of the experiment made up Group V and resulted in unhealthy growth and variable vigour. Common symptoms were wind throw, limb breakage, partial or complete dieback and general chlorosis caused by waterlogged soils, particularly on the middle and lower beds. Plates 2(a), (b) and (c) show the difference in the performance of the same species watered at 1/3, drip and 5/3 irrigation rates respectively.

Plate 1. Elevated view of lower and middle test beds at the end of the experiment. View looking north.
Plate 2(a). View of same set of plants in test beds middle 1 (1/3 treatment).

Plate 2(b) and (c). View of same set of plants in test beds middle 2 (drip) and middle 3 (5/3) respectively.

Table 4: Health and vigour profiles for the irrigation treatments and natural rainfall at the three evaluation times. Final column of figures from Lay (1983). Ratings scale as for Table 2.

		Health						Vigour						Perform.
March 1980	Treatment	0	1	2	3	4	5	0	1	2	3	4	5	Score
March 1980	Rain	22	1	2	20	50	43	22	13	25	32	32	14	6.6
	Drip	3	2	3	8	33	89	3	6	15	25	38	51	8.3
	1/3	12	2	5	9	54	56	12	10	17	34	43	22	7.3
	3/3	5	7	6	15	28	77	5	7	11	19	35	61	8.1
	5/3	11	9	8	34	45	31	11	14	21	25	43	24	6.5
July 1982	Rain	27	2	4	26	36	43	27	9	19	23	38	22	6.0
	Drip	13	5	5	11	27	77	13	8	9	20	24	64	7.7
	1/3	17	2	4	26	44	45	17	9	9	29	46	28	6.7
	3/3	29	2	9	14	30	54	29	9	4	20	25	21	6.5
	5/3	40	5	8	36	28	21	40	9	19	23	31	16	4.9
May 1983	Rain	29	2	5	13	31	58	29	8	24	25	30	22	6.0
	Drip	24	2	14	13	38	47	24	5	9	21	28	51	6.9
	1/3	21	5	10	14	40	48	21	11	10	30	42	24	6.3
	3/3	33	5	9	17	32	42	33	8	8	15	31	43	6.2
	5/3	40	4	12	18	33	31	40	15	10	26	25	22	5.1

The effect of cessation of irrigation was most noticeable with the drip irrigation treatment (Table 4). There was a rapid decline in health and vigour from July 1982 to May 1983. This was during a period of severe drought. This rapid deterioration may have been due to the more confined root distribution of some species because of the restricted zone of soil wetting around each water source (Lay 1983) compared with the sprinkler treatments. When watering ceased, the plants were not able to draw moisture from a larger volume of soil as would be the case for the sprinkler irrigation treatments. The plants in the 5/3 irrigation rate improved when irrigation ceased as excess water was able to drain away and soil aeration improved as a result.

Conclusion

Most of the species planted at Monarto were chosen as being hardy or salt tolerant plants commonly under cultivation. Group I and particularly Group II species proved suitable for amenity plantings at Monarto. These plants are recommended in environments similar to that at Monarto and are tolerant of a wide range of soil and climatic conditions as experienced at the experimental site. Drip irrigation gave by far the best results in terms of amount of water used to establish healthy and vigorous plants. A significant point revealed by the experiment is that many species are able to perform well without any irrigation even on this exposed site.

References

Alvey, N.G. et al. (1977). "GENSTAT—A General Statistical Program". Rothamsted Experimental Station. (Numerical Algorithms Group Limited: Oxford, England).

Dubois, B. (1977). Monarto Irrigation Experiment Station—First Annual Report 1976/77. (South Australian Department of Agriculture). *Soil Conservation Branch Report* S18/77.

Gower, J.C. (1971). A general coefficient of similarity and some of its properties. *Biometrics* 27 (4): 857-872

Lay, B.G. (1980). Assessment of Amenity Treeplantings at the Monarto Irrigation Experiment Station. (South Australian Department of Agriculture). *Soil Conservation Branch Report* S7/80.

Lay, B.G. (1983). Effects of Irrigation Regimes on Performance of Native Plants Under Cultivation pp 31-43 In "Biology of Native Plants Under Cultivation". (South Australian Department of Environment and Planning: Adelaide).

Lay, B.G. and Meissner, A.P. (1985). An Objective Method For Assessing The Performance Of Amenity Plantings (this issue).

Matheson, W.E. and Barwick, I. and Associates (1975). "Report on the proposed Irrigation Experiment Station for the Monarto Development Commission". (Unpublished Report).

Northcote, K.H. (1960). A Factual Key for the Recognition of Australian Soils. (Rellim Technical Publications: Adelaide).

Schrale, G. (1976). Hydrological Background Information and Operation Schedule for the Monarto Irrigation Experiment Station. Report to the S.A. Department of Agriculture and Fisheries. *The Flinders University of South Australia. Publication* No. T/4/10.

J. Adelaide Bot. Gard. 7(2) 181-200 (1985)

A TAXONOMIC REVISION OF THE GENUS *VITICIPREMNA* H.J. Lam (VERBENACEAE)*

Ahmad Abid Munir

State Herbarium, Botanic Garden, North Terrace, Adelaide, South Australia, 5000

Abstract

A taxonomic revision of *Viticipremna* is presented. The following five species are recognised: *V. tomentosa* Munir, *V. queenslandica* Munir, *V. vitilevuensis* Munir, *V. philippinensis* (Turcz.) H.J. Lam and *V. novae-pommeraniae* (Warb.) H.J. Lam. *V. tomentosa* (from Papua New Guinea), *V. queenslandica* (from Australia) and *V. vitilevuensis* (from Fiji) are described as new. The latter two are respectively the first representative species of this genus from Australia and Fiji. The genus and the type species are typified.

The affinities and distribution are considered for the genus and each species, a key to the species is provided and a detailed description of each species is supplemented by a habit sketch of a flowering branch and analytical drawings of the flowers.

Taxonomic History of the Genus

The genus *Viticipremna* was established by Lam (1919), and two species were recorded, viz. *V. turczaninowii* and *V. novae-pommeraniae*. It was referred to the family Verbenaceae where it was placed in the subfamily ("tribe") Viticoideae, tribe ("subtribe") Viticeae. This position was accepted by Moldenke (1959, 1971, 1980). Merrill (1923), however, relegated *Viticipremna* to synonymy in *Vitex* and remarked that he could see no valid reason for recognising the genus *Viticipremna*. In March, 1951, however, Merrill annotated one of Cuming's collections in the BM as the type of *Viticipremna*. Airy Shaw (1973) recorded this genus in the family Verbenaceae, without reference to any subfamily or a tribe. In 1982, Moldenke recorded *Viticipremna* in the synonymy of *Vitex* without any comment. Up to the present revision, only the two (syntype) species were recognised in the genus. Most collections belonging to this genus have been identified as *Vitex* species.

VITICIPREMNA H.J. Lam

Viticipremna H.J.Lam, Verben. Malay. Archip. (1919) 162; Bull. Jard. Bot. Buitenz. 3, 3 (1921) 47; Mold., Résumé Verben. etc. (1959) 409; Fifth Summary Verben. etc. 2 (1971) 758; Airy Shaw, Willis' Dict. Fl. Pl. & Ferns edn 8 (1973) 1214; Farr et al., Index Nom. Gen. Pl. 3 (1979) 1852; Mold., Sixth Summary Verben.etc. (1980) 460; Phytologia 50, No.4 (1982) 267, as syn. of *Vitex*; Phytologia 51, No. 4 (1982) 246, as syn. of *Vitex*.

Lectotype: *V. philippinensis* (Turcz.) H.J. Lam, Bull. Jard. Bot. Buitenz. 3, 3 (1921) 47, lectotype designated here.

Vitex auct. non L.: Merr., Enum. Philip. Fl. Pl. 3 (1923) 398 p.p., quoad *V. turczaninowii* Merr.

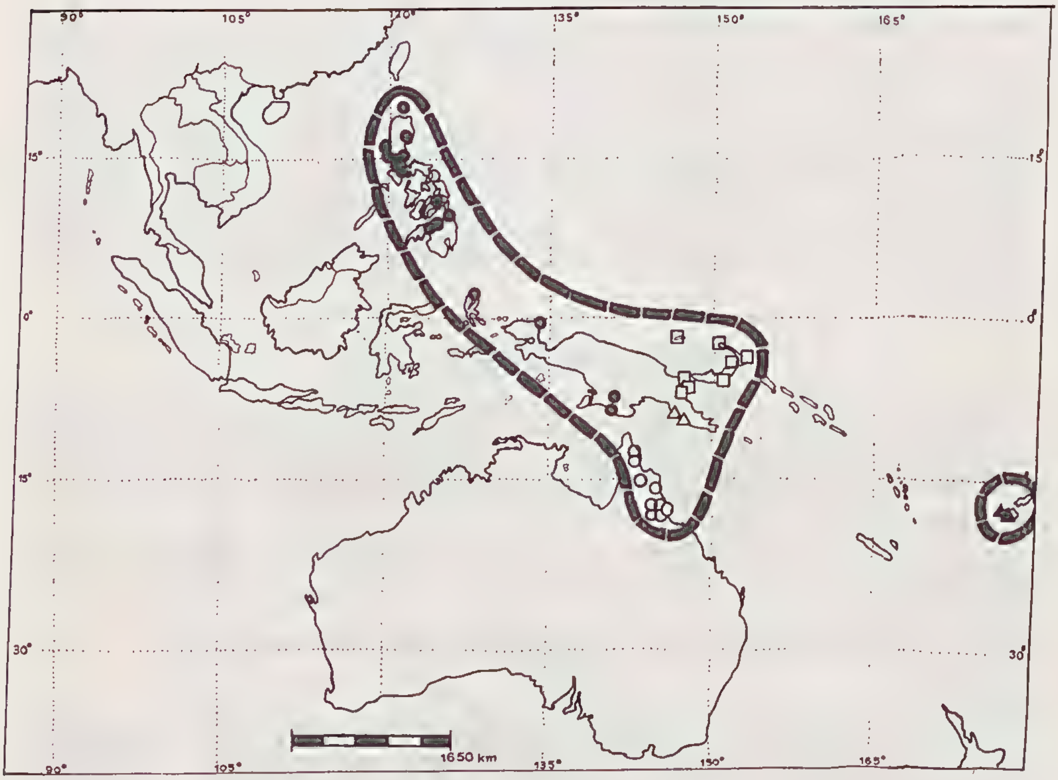
Typification

Lam (1919) included two species in the genus *Viticipremna*, viz. *V. turczaninowii* (Merr.) H.J.Lam (later renamed as *V. philippinensis* (Turcz.) H.J. Lam) and *V. novae-pommeraniae* (Warb.) H.J. Lam. Since the author did not choose a type, it is necessary to select a lectotype. Of the two syntypes, *V. philippinensis* is based on an older valid name. It is more widespread and in all major characteristics a better representative of *Viticipremna*. It is, therefore, selected here as the lectotype for this genus.

*The present treatment of the genus *Viticipremna* is the fourth in the series of taxonomic revisions in the family Verbenaceae (See Munir, 1982, 1984, 1984a).

Tall shrubs or trees. *Stem* and branches almost terete or vaguely quadrangular. *Leaves* digitately compound, decussate, exstipulate, petiolate; leaflets 3-6 (-7), reticulate-veined, unicostate, usually petiolulate. *Inflorescence* terminal, cymose, compound and often much branched, pedunculate. *Flowers* complete, zygomorphic, bisexual. *Calyx* of 4 sepals, persistent, accrescent, tubular, truncate or shortly 4-dentate. *Corolla* of 4 fused petals, deciduous, tubular below, sub-bilabiate above, the upper lip usually entire, the lower lip 3-lobed with the middle lobes larger, with a villous band in tube. *Stamens* 4, didynamous, alternate with the corolla-lobes, inserted inside the corolla-tube; filaments filiform, glabrous; anthers dorsifixed, oblong or elliptic, 2-lobed, lobes longitudinally dehiscent. *Ovary* bicarpellary, syncarpous, 4-locular, with one ovule in each cell attached to an axile placentation at or above the middle; style filiform, with 2 short stigmatic lobes. *Fruit* a small globose succulent drupe, with a hard 4-celled undivided pyrene. *Seeds* exalbuminous.

Number of species: 5.



Map 1. Distribution of the genus *Viticipremna* H.J. Lam
V. novae-pommeraniae □ ; *V. philippinensis* ● ; *V. queenslandica* ○ ; *V. tomentosa* △ ; *V. vitilevuensis* ▲

Derivation of Name

The generic name is derived from *Vitex* and *Premna*. The digitate leaves of *Vitex* and 4-lobed corolla of *Premna* are the characteristics of this genus.

Distribution (Map 1)

The genus *Viticipremna* is distributed in Malesia, Melanesia and north-eastern Australia. In Malesia, it has been recorded from the Philippine Islands, Moluccas, Irian Jaya, Papua New Guinea, Admiralty Islands, Bismarck Islands, New Britain and New Ireland. In Australia, it has been recorded from the coastal regions of northern Queensland north of 20°S latitude. Beside the above distribution range, the genus has now been recorded from Fiji in Melanesia.

In addition to the accepted range of distribution, Moldenke (1959, 1971, 1980) and Airy Shaw (1973) recorded this genus from Java, Moldenke (1980) from Kalimantan and Lam (1919) from New Zealand. During present investigations, however, no representative of *Viticipremna* was found to occur in any of these areas. The occurrence of this genus in New Zealand was not reported by Allan (1961). In fact, the family Verbenaceae in New Zealand is represented by only two genera, *Vitex* L. and *Teucridium* Hook.f., each with one species.

Comments

In the protologue of this genus, Lam (1919) made the following remarks: "We based the present genus upon 2-lobed corolla, which is a characteristic of *Premna*, and the digitate leaves, which are a feature of *Vitex*. Moreover, the throat of the corolla is villous before the upper instead of before the mid-lobe of the lower lip. Yet we conceive, that it may be a doubtful one, since the possibility exists that it may be either a hybrid of *Premna* and a *Vitex* species, or a variation of the latter genus".

The mention of a "2-lobed corolla" seems to be a printing mistake, because elsewhere the author mentioned the number of corolla-lobes as 4. The position of villous hairs in the corolla-throat is found to be opposite to the above expressed view. In fact, the corolla-throat is found to be villous in front of the mid-lobe of the lower lip instead of before the upper lip. This particular character, however, is found only in *V. vitilevuensis* and *V. novae-pommeraniae*, though all *Viticipremna* species do have a villous band of hairs inside the corolla-tube.

Lam (1919) considered this genus as a possible hybrid of a *Premna* and a *Vitex* species, or a variation of the latter genus. He did not, however, name any species which may have cross-bred to produce a hybrid. Subsequently, Lam (1921) made comments on both type species and said: "So we think that the genus really is a good one". During present investigations, a range of specimens of each *Viticipremna* species have been examined, and the consistent combination of the following characters was found: Leaves composed of digitate leaflets; calyx-tube 4-toothed to almost truncate; corolla distinctly 4-lobed; stamens didynamous, epipetalous; ovary bicarpellary, syncarpous, with a filiform style and a short bifid stigma. Of these, the leaf-character is that of *Vitex*, calyx and corolla of *Premna,* and stamens, style and ovary common between these genera. The consistent combination of these characters, however, is exclusive to *Viticipremna*, and it has been accepted here as a distinct genus; and its affinities are as follows.

Affinities

Viticipremna is closely related to *Vitex* in its leaves being digitate; calyx persistent and accrescent; corolla-tube short, cylindrical, villous inside; stamens 4, didynamous; style with short bifid stigma; fruit a drupe with one 4-celled pyrene. Nevertheless, *Viticipremna* may easily be distinguished by its 4-lobed corolla and calyx truncate or obsoletely 4-denticulate. *Viticipremna* is also related to *Premna* in having a more or less similar shaped inflorescence composed of cymes; corolla 4-lobed, tube cylindrical and villous inside; stamens 4, didynamous; style with 2 short stigmatic lobes; fruit a succulent drupe with a hard 4-celled undivided pyrene. However, *Premna* can be readily identified by its simple leaves.

Key to the Species

1a. Leaflets densely tomentose below, pubescent above; cymes sessile or almost so and arranged in distant verticillate clusters along the rachis; middle lobe of the lower corolla-lip villous on the inner surface ... 1. *V. tomentosa*

b. Leaflets glabrous; cymes pedunculate, arranged in more or less lax pyramidal panicles; middle lobe of the lower corolla-lip glabrous, glandular-puberulous or villous on the inner surface 2

2a. Stamens and style much exserted beyond the corolla-lobes; ovary non-glandular 4

b. Stamens and style included or almost so; ovary glandular 3

3a. Calyx glabrous but glandular outside, 4-lobed at the top, more or less 2-lipped; corolla-tube more or less twice the length of calyx, anterior corolla-lobe glandular-puberulous on the inner surface .... 2. *V. queenslandica*

b. Calyx pubescent and glandular outside, truncate, not lipped; corolla-tube scarcely longer than calyx, anterior corolla-lobe villous on the inner surface .... 3. *V. vitilevuensis*

4a. Leaflets lanceolate to narrowly elliptic-lanceolate, cuneate at base; stamens inserted in the middle part of the corolla-tube; corolla-lobes glabrous inside at the base .... 4. *V. philippinensis*

b. Leaflets ovate, ovate-oblong or ovate-lanceolate, unequally obtuse or subtruncate at base; stamens inserted in the upper part of the corolla-tube; anterior corolla lobe villous inside at the base ..... 5. *V. novae-pommeraniae*

1. **Viticipremna tomentosa** Munir, sp. nov.

Frutex vel arbor parva (1.5-) 4-7 (-9) m alta. Truncus dense pubescentio-tomentosus ubi juvenis. *Folia* 3-5-foliolata; foliola elliptica vel elliptico-lanceolata, integra, supra pubescentia, subtus tomentosa, sessilia vel breviter petiolulata, (3.5-) 5-12 (-17.5) cm longa, (2-) 3.5-5 (-6.5) cm lata; petioli tomentosi, glandiferi. *Inflorescentia* terminalis; cymae fere sessiles, in fasciculis distantibus verticillatis secus rachem dispositae. *Flores* subsessiles. *Calyx* tubulus, minute 4-dentatus, externe glandifer pubescensque, interne glaber, 1-1.5 (-2) mm longus. *Corolla* cremeo-alba, superne 4-lobata, inferne tubulosa, externe glandifer vel pubescens, tubo interne villosus. *Stamina* breviter exserta, didynama, epipetala; filamenta filiforma, glabra; anthera plus minusve orbiculata, lobi in dimidio inferiore discreti. *Ovarium* globulosum, glabrum, apice glandiferum; stylus inclusus, filiformis, glaber. *Fructus* globulo-ellipsoideus, glaber, succulentus, rubro-fuscus vel purpureus, 6-8.5 mm longus, 5-6.5 (-7) mm diametro.

Type: *R. Pullen 6825,* Tavai Creek area, c. 46 miles S.E. of Port Moresby, Central District, Papua New Guinea, 28.iv.1967 (CANB, holotype; A, BISH, BO, BRI, DUH, E, G, K, L, LAE, P, PNH, SING, TNS, UC, US, -isotypes).

Description (Fig. 1)

Shrub or small tree (1.5-) 4-7 (-9) m tall. *Stem:* trunk more or less 7 cm diameter, bark light-brown or fawn-grey, irregularly cracked vertically; young branches glandular and densely pubescent-tomentose. *Leaves* 3-5-foliolate; leaflets almost sessile or with short petiolules, narrowly elliptic or elliptic-lanceolate, with long acuminate apex, cuneate at the base, entire, (3.5-) 5-12 (-17.5) cm long, (2-) 3.5-5 (-6.5) cm broad, chartaceous, light-green and pubescent above, paler and densely tomentose below; pairs of nerves 6-8 (-10); petioles tomentose, glandular, (3-) 4-6.5 (-7.5) cm long; petiolules absent or the terminal one 2-5 (-8) mm long, tomentose, glandular. *Inflorescence* terminal, glandular and tomentose, 16-24 cm long, 14-20 cm wide; cymes sessile or almost so, decussately arranged in distant verticillate clusters along the rachis, each cyme 3-5 (-7) flowered; pedicels densely pubescent-tomentose, glandular, 1-2 (- 3) mm long; flowers "fragrant", subsessile; bracts minute, densely glandular and pubescent-tomentose, more or less 1 mm long. *Calyx* tubular, with 4 or rarely 5 minute lobes at the top, glandular and pubescent outside, glabrous inside, persistent, accrescent; tube cylindrical, 1-1.5 (- 2) mm long, 1.5-1.7 mm in diameter at the top; lobes obtuse 0.5-0.7 mm long, 1-1.5 mm broad at the base. *Corolla* cream-white, 4-lobed in the upper half, tubular below, glandular and pubescent outside, villous inside the tube and on the inner surface of the large anterior lobe (i.e.lip); tube more or less cylindrical, about twice the length of calyx, glabrous towards the base, 3-4 mm long, 1.5-1.8 (-2) mm in diameter; lobes more or less elliptic-orbicular or elliptic-ovate, obtuse; the anterior lobe largest, developed as a lip, almost orbicular in outline, (2-) 2.5- 3.5 mm long, nearly as broad; the other lobes (1.5-) 2-2.5 mm long, 1.5-2.3 (-2.5) mm broad at the base. *Stamens* slightly exserted, didynamous, inserted

Fig. 1. *Viticipremna tomentosa* Munir (A-I, *R. Pullen 6825*: CANB, holotype; *J, R. Pullen 6911*: BRI). A, flowering branch; B, cyme; C, ovary; D, transverse section of ovary; E, flower; F, flower vertically cut open showing androecium and gynoecium; G, calyx showing 4 lobes; H, portion of leaf showing short septate hairs on upper surface; I, portion of leaf showing long septate (tomentose) hairs on the lower surface; J, fruit with persistent calyx.

inside the corolla-tube; filaments filiform, glabrous, villous near the base only, the anterior pair 3-3.5 mm long, the lateral pair 2.5-3 mm long; anthers more or less orbicular in outline, 0.5-1 mm long, 0.5-0.8 mm broad, lobes free and divergent in the lower half, narrowing towards the free end. *Ovary* globular, glabrous, glandular at the top, more or less 1 mm in diameter; style included, filiform, glabrous, 2-2.5 (-3) mm long, stigma minutely 2-fid. *Fruit* succulent, globular-ellipsoid, glabrous, light-green, tinged reddish-brown or purple, 6-8.5 mm long, 5-6.5 (-7) mm in diameter; fruiting calyx accrescent, 5-7 mm in diameter.

Specimens examined

PAPUA NEW GUINEA: *Pullen 3248*, near Kwalimurupu village, Rigo sub-district, Papua, 9.vii.1962 (A, CANB, L, LAE); *Pullen 6825,* Tavai Creek area, c. 74 km S.E. of Port Moresby, Central District, 28.iv.1967 (CANB, holotype; A, BISH, BO, BRI, DUH, E, G, K, L, LAE, P, PNH, SING, TNS, UC, US—isotypes); *Pullen 6911,* between Manugoro and Kapakapa, c. 72.41 km S.E. of Port Moresby, Central District, 5.v.1967 (A, BO, BRI, CANB, E, G, K, L, LAE, PNH, US); *Schodde 2755,* c. 1.6 km N of Rigo, Central District, Papua, 11.viii.1962 (A, BH, BO, BRI, E, G, K, L, LAE, PNH, US); *Streimann NGF 26189*, near Korimurubu Village, Central District, Papua, 5.ii.1966 (A, BISH, BO, BRI, CANB, K, L, LAE, PNH, SING, SYD, UC, US).

Distribution (Map 1)

V. tomentosa seems to be endemic to Papua New Guinea where it is known to occur chiefly to the south-east of Port Moresby. Most of the localities are around Rigo township in the Central district of the country.

Comments

This is the only species of *Viticipremna* with leaves densely tomentose on the lower surface, and cymes almost sessile and arranged decussately in distant verticillate clusters along the rachis.

The calyces are generally 4-lobed at the top, but occasionally a few 5-lobed calyces were also noticed in some collections.

In every mature flower dissected, the style was found to be detached from the ovary, and in most cases missing. After examining a range of flowers from pre-anthesis to post-anthesis stage, it was found that the style is deciduous during anthesis or soon after the opening of its corolla. It appears as if the flowers in this species are self pollinated, and the fertilization apparently takes place just before the opening of the corolla-tube or soon afterwards. In unopened mature flower-buds, the anthers and stigma were found to be fully developed, and in some cases the pollen grains were found attached to the stigma.

Affinities

V. tomentosa is closely related to *V. queenslandica* in its leaflets being tapered at both the ends; calyx distinctly 4-lobed at the top, more or less 2-lipped; style included; stamens almost included or scarcely exserted beyond the corolla-tube; ovary glandular on top. Nevertheless, *V. tomentosa* may readily be identified by its leaflets being densely pubescent-tomentose; cymes sessile, arranged into distant verticillate clusters along the rachis, and the middle lobe of the lower corolla-lip villous on the inner surface.

There are a few characters common between *Viticipremna tomentosa, Vitex altissima* L.f.and *Vitex agnus-castus* L. All three have a more or less similar type of inflorescence with sessile cymes arranged into verticillate clusters along the rachis. The latter two, however, can easily be distinguished by their leaflets being sessile, linear, lanceolate or narrowly ovate-lanceolate, glabrous or minutely white-mealy. They can also be recognised by their flower characters which are distinctive of the genus *Vitex*. For the relationship between *Viticipremna tomentosa* and *V. vitilevuensis*, see "affinities" under the latter.

2. **Viticipremna queenslandica** Munir, sp. nov.

Vitex acuminata auct. non R.Br.: Benth., Fl. Aust. 5 (1870) 67, p.p., quoad spec. *J. Dallachy s.n.*, Rockingham Bay, Qld.

Arbor 15-30 m alta. *Truncus* 30-75 (-100) cm diametro; rami juvenes glabri, glandiferi. *Folia* 3-5-foliolata; foliola elliptico-lanceolata vel elliptico-ovata, acuminata, basi cuneata (4-) 6-13 (-16) cm longa, (2-) 3-4 (-5.5) cm lata, chartacea, glabra, supra nitida, inferne glandifera, petiolo glabro, glandifero, 2.5-7 (-9) cm longo; petioluli (2-) 3-10 (-15) mm longi. *Inflorescentia* terminalis, laxa, glandifera, puberula vel fere glabra; cymae paniculis pyramidalibus dispositae. *Flores* pedicellati; pedicelli glandiferes, 1.5-2.5 (-3) mm longi. *Calyx* tubulus, truncatus vel leviter 4-dentatus, glaber, externe glandulifer. *Corolla* cremeo-alba, superne 4-lobata, inferne tubula, externe pubescentia glanduliferaque; tubus interne villosus. *Stamina* leviter exserta, didynama; filamenta filiforma, glabra; anthera plus minusve circumscriptione orbicularis lobis in dimidio inferione discretis. *Ovarium* globulum, glabrum, glanduliferum; stylus glaber, filiformis. *Fructus* globulo-ellipsoideus, glaber, aurantiaco-luteus ubi maturus, siccitale brunneus, 6-10 mm longus, 4-7(-8) mm diametro.

Type: *B. Hyland 9633*, State Forest Reserve 310, Goldsborough L.A., Queensland, Australia, 18.1.1978 (QRS, holotype; AD, QRS, -isotypes).

Description (Fig. 2).

Tree 15-30 m tall. *Stem*: trunk 30-75 (-100) cm in diameter, fluted and buttressed with slightly fissured bark; young branches glabrous, densely covered with yellowish glands. *Leaves* 3-5-foliolate; leaflets narrowly elliptic, elliptic-lanceolate or elliptic-ovate, with acuminate apex, cuneate at the base, entire, (4-) 6-13 (-16) cm long, (2-) 3-4 (-5.5) cm broad, chartaceous, glabrous, with yellowish glands on the lower surface, nitid above, pair of nerves 5-8 (-10); petioles glabrous, glandular, 2.5-7 (-9) cm long; petiolules glabrescent, glandular, (2-) 3-10 (-15) mm long. *Inflorescence* terminal, somewhat lax, glandular, puberulous or almost glabrous, 15-25 cm long, 10-20 cm wide; cymes in more or less pyramidal panicles; lateral primary peduncles 2-5 cm long; flowers pedicellate; pedicels densely glandular, 1.5-2.5 (-3) mm long; bracts minute, glandular. *Calyx* almost truncate or with 4 short lobes at the apex, more or less 2-lipped,glabrous, glandular outside, persistent and somewhat accrescent; tube cylindrical, 2-3 mm long, 1.5-2 mm in diameter at the top; lobes rounded or shortly acute, more or less 0.5 mm long, 0.5-1 mm broad at the base. *Corolla* cream-white, 4-lobed in the upper part, tubular below, pubescent and glandular outside, glandular-puberulous on the inner surface of the lobes, villous inside the tube and throat; tube more or less cylindrical, about twice the length of calyx, glabrous near the base, 4-5 mm long, 2-2.5 mm in diameter; lobes elliptic-oblong, ovate or almost orbicular, obtuse, 2-3 mm long, (1.5-) 2-3 mm broad, the anterior lobe somewhat 1arger than the others. *Stamens* included or lightly exserted beyond the corolla tube, (included in *B. Hyland 9251*), didynamous, inserted in the lower half of the corolla-tube; filaments filiform, glabrous above, villous in the lower half, the anterior pair longer, 3.5-4.5 mm long, (more or less 0.7 mm long in *B. Hyland 9251*), the lateral pair 3-4 mm long, (more or less 0.5mm long in *B. Hyland 9251*); anthers more or less orbicular in outline, lobes free and divergent in the lower half, narrowing towards the free end, more or less 1 mm long, and 0.5 mm broad, (more or less 0.5mm long in *B. Hyland 9251*). *Ovary* globular, glabrous, glandular at the top, 1-1.2 mm in diameter; style almost included, glabrous, filiform, 3-3.5 mm long, (exserted and more or less 4 mm long in *B. Hyland 9251*); stigma minutely 2-fid. *Fruit* almost globular or ellipsoid, glabrous, "orange-yellow" when ripe, drying brownish, 6-10 mm long, 4-7 (-8) mm in diameter.

Representative specimens (Collections seen: Australian 35, non-Australian 0).

AUSTRALIA: QUEENSLAND: *Cowley 73a*, Cook district, undated (BRI, 2 spec.). *Dallachy s.n.*, Rockingham Bay, 27.ii.1865 (K, MEL 97905, MEL 97910). *Dockrill 18*, Yungaburra, 22.iv.1971 (BRI, L, QRS). *Dockrill 746*, Table Range, Dead Horse Creek, 23.x.1973 (QRS). *Francis s.n.*, Atherton Tableland, 5.v.1928 (BRI). *Gray 1220*, S.F.R.933, Little Pine L.A., 16° 59'.S, 145° 50'E, 20.xii.1978 (AD, QRS 2 spec.). *Gray 2439*, S.F.R. 191, 17° 19'S, 145° 30'*E, 22.ii.1982 (QRS). Gray 2515*, S.F.R.191, 17° 18'E, 145° 30'*E, 30.iii.1982 (QRS, 2 spec.). Gray 2529*, S.F.R. 191, loc. cit., 15.iv.1982 (QRS 2 spec.). *Hyland 1067*, Noah Creek, 11.x.1967 (QRS). *Hyland 1536*, Wyvuri

Fig. 2. *Viticipremna queenslandica* Munir (A-H, *B. Hyland 9633*: AD, isotype; I, *K.J. White s.n.*: BRI 219424). A, flowering branch; B, enlarged portion of leaf showing glands on the lower surface; C, cyme; D, flower; E, calyx; F, flower vertically cut open to show androecium and gynoecium; G, ovary; H, transverse section of ovary; I, fruit with persistent calyx.

Holding, 26.vi.1968 (QRS). *Hyland 5487*, Rocky River, 14.ix.1971 (L, QRS). *Hyland 9251*, S.F.R. 675, East Mulgrave L.A., 22.xii.1976 (BRI, L, QRS—specimens with abnormal stamens and style). *Hyland 9633*, S.F.R. 310, Goldsborough L.A., 18.i.1978 (QRS, holotype; AD, QRS, —isotypes). *Jones 676*, Wongabel, 5 miles S. of Atherton, 3.ix.1957 (JCT). *Jones S244O*, Atherton, 30.iv.1959 (JCT). *Nicholson s.n.*, Tolga Scrub, -.iv.197O (QRS). *Risley 432*, State Forest Reserve, 933, 1.ii.1978 (QRS). *Sanderson 1459*, State Forest Reserve 185, Townsville, 24.v.1978 (QRS). *Smith 3796*, Cook, 17° 20'S, 145° 28'E, 18.viii.1948 (QRS).*Unwin 246*, S.F.R. 310, Gadgarra, 24.iii.1977 (QRS). *Unwin 569*, C.S.I.R.O.Plot, Palmerston Highway, Innisfail, 28.vi.1978 (QRS). *White s.n.*, Cook District, R.31O, 17° 01'S, 145° 04'E, 18.vi.1953 (BRI, L). The following two collections by L.J. Webb & J.G. Tracey lack flowers or fruits, but seem to belong to this species: *Webb & Tracey 7368*, McIlwraith Range, NE of Coen, 1962 (BRI, CANB). *Webb & Tracey 12O96*, Timber Camp Rd on road between Daintree & Bloomfield Rd, via China Camp, 24.viii.1972 (BRI, CANB).

Distribution (Map 1).

V.queenslandica is endemic to Australia where the main distribution is in the north-eastern coastal region of Queensland. Within this area, it occurs chiefly between latitudes 16° and 19°S, and longitude 145° and 147°E. Most localities are on the coastal area of the Atherton Tableland between Mossman and Rockingham Bay. Outside the above distribution area, only one collection from Cape York Peninsula has come from north-east of Coen in the McIlwraith Range.

Comments

This species is the only known representative of *Viticipremna* in Australia. Previously, it had been misidentified as *Vitex acuminata* R.Br. which has more or less similar leaves and inflorescence. The latter, however, may easily be distinguished by its corolla being distinctly 5-lobed, calyx pubescent outside and stamens and style much more exserted beyond the corolla-tube.

B. Hyland's collection no. 9251 (QRS) seems to have abnormal stamens and style. The stamens in his collection are relatively much smaller and completely included, and the style somewhat more exserted. In all other characters, however, this collection fits well within the species.

The adult leaflets are entire, but at seedling stage almost all leaflets are deeply dentate. Similarly dentate-margined leaflets are also found in the seedlings of *Vitex glabrata* R.Br.

Affinities

V. queenslandica is closely allied to *V. philippinensis* in its leaflets being glabrous, tapered at both ends; cymes pedunculate, arranged in more or less pyramidal panicles; corolla pubescent and glandular outside. Nevertheless, *V. queenslandica* can easily be distinguished by its branchlets and inflorescence being glabrous, densely covered with yellowish glands; calyx is glabrous but glandular outside, 4-toothed at the top, more or less 2-lipped; stamens and style almost included or slightly exserted above the corolla-tube, and ovary glandular on top.

V. queenslandica is also related to *V. tomentosa* and *V. vitilevuensis*. For details see "affinities" under these species.

3. **Viticipremna vitilevuensis** Munir, sp. nov..

Vitex quinata (Lour.) F.N. Will. var. *puberula* (H.J. Lam) Mold., Phytologia 3 (1951) 489, p.p., quoad spec. *A.C. Smith 43O7 & 6295* from Viti Levu, Fiji; Phytologia 49 (1981) 457-459, p.p., quoad spec. *W. Greenwood 344A* from Viti Levu, Fiji.

Vitex turczaninowii Merr. f. *puberula* (H.J. Lam)Mold., Phytologia 51, No. 2 (1982) 163, p.p., quoad spec. in Herb. A & US.

Arbor 15-20 m alta. *Truncus* cylindricus, cortice fissura, ramis juvenibus puberulis glandiferisque. *Folia* 3-5-foliolata; foliola elliptico-lanceolata, integra, acuminata, basin versus cuneata, 5-16 cm longa, 2.5-8.5 cm lata,

Fig. 3. *Viticipremna vitilevuensis* Munir (A-G, *A.C. Smith 8881*: L, holotype; H, *A.C. Smith 4307*: L). A, flowering branch; B, cyme; C, flower; D, flower vertically cut open showing androecium (partly obscured by hairs) and gynoecium; E, enlarged calyx; F, ovary; G, transverse section of ovary; H, fruit with persistent calyx.

chartacea, glabra, dorsaliter glandifera; petioli (0.5-) 1-2.5 cm longi. *Inflorescentia* terminalis, glandifera, puberula; cymae paniculatae, plus minusve pyramidales; pedicelli 1-2 mm longi. *Calyx* tubulus, fere truncatus, externe pubescens glandiferaque, interne glaber, 1.5-2.5 mm longus. *Corolla* superne 4-lobata, inferne tubula, externe pubescens glandiferaque, in tubo et lobi anterioris superficie villosa; tubus vix magis longus quam calyx; lobi plus minusve elliptico-orbiculares. *Stamina* inclusa, plus minusve didynama; filamenta usque 1.5 mm longa; antherae plus minusve 0.5 mm longae. *Ovarium* globulosum, glabrum, glandiferum; stylus inclusus glaber, filiformis, 2.5-3 mm longus. *Fructus* globosus, glaber, 4-5 mm longus, fere quam latus.

Type: *A.C. Smith 8881*, Namosi, hills bordering Wainavindrau Creek, in vicinity of Wainimakutu, alt. 150-250 m., Namosi, Viti Levu, Fiji, 17.ix-8.x.1953 (L, holotype; A, BISH, US—isotypes).

Description (Fig. 3)

Tree 15-20 m tall. *Stem* cylindrical, glabrous, with slightly fissured bark; young branches puberulous, densely covered with minute yellowish glands. *Leaves* 3-5-foliolate; leaflets narrowly elliptic or elliptic-lanceolate, with acuminate apex, cuneate towards the base, entire, (5-) 7-12 (-16) cm long, (2.5-) 4-7 (-8.5) cm broad, chartaceous, glabrous, with yellowish glands on the lower surface, nitid above, pair of nerves 6-10; petioles puberulous, glandular, but becoming glabrescent, (3-) 4-10 cm long; petiolules puberulous, glandular, (0.5-) 1-1.5 (-2.5) cm long. *Inflorescence* terminal, glandular, puberulous, 11-30 cm long, 10-15 cm wide; cymes in more or less pyramidal panicles; lateral peduncles 2-6 cm long; flowers "fragrant"; pedicels glandular, pubescent, 1-2 mm long; bracts minute, linear, glandular and pubescent. *Calyx* tubular, almost truncate or with 4 minute teeth at the apex, pubescent and glandular outside, glabrous within; tube cylindrical, 1.5-2.5 mm long, 1.5-2 mm in diameter at the top; lobes scarcely 0.5 mm long, 0.5-1 mm broad at the base. *Corolla* "white, purple tinged within at throat", 4-lobed above, tubular below, pubescent and glandular outside, glandular-puberulous on the inner surface of the lobes, villous inside the tube and throat with hairs extending to the inner surface of the anterior lobes; tube more or less cylindrical, scarcely longer than calyx, glabrous near the base, 2-2.5 (-3) mm long, 1.5-2 (-2.5) mm in diameter; lobes broadly elliptic or almost orbicular, anterior lobe larger than the others, (2-) 2.5-3 (-4) mm long, 2.5-3 (-3.5) mm broad, densely villous-pubescent on the inside, other lobes broadly elliptic or almost orbicular in outline, 2-2.5 mm long, 2-2.5 (-3.5) mm broad. *Stamens* included, more or less didynamous, inserted in the middle of the corolla-tube; filaments filiform, glabrous in the upper half, villous near the base, anterior pair (1-) 1.2-1.5 mm long, lateral pair 0.8-1 mm long; anthers elliptic-oblong, more or less 0.5 mm long. *Ovary* globular, glabrous, glandular on top, 1-1.5 mm in diameter; style included, glabrous, filiform, 2.5-3 mm long, stigma shortly bifid. *Fruit* globose, glabrous, 4-5mm long, nearly as much in diameter.

Specimens examined

FIJI: VITI LEVU: *Degener 14481*, Tholo North, vicinity of Nandarivatu 750-900 m, 4.ii-26.iii.1941 (A, NY). *Greenwood 344A*, Lautoka, mountains, alt about 550 m, ii-iii.1941 (A). *Gillespie 2953*, Namuamua, Namosi Prov., 22.ix.1927 (NY); *Gillespie 4164.1*, Tholo-North Prov., 3.xii.1927 (NY). *Smith 6295*, Mba, slopes of the escarpment north of Nandarivatu, alt. 550-800 m, 15-29.ix.1947 (A, BISH, L, NY, US); *Smith 8881*, Namosi, hills bordering Wainavindrau Creek, in vicinity of Wainimakutu, alt. 150-250 m, 17.ix-8.x.1953 (L, holotype; A, BISH, US, —isotypes). *A.C. Smith 9119*, Serua, hills east of Navua River, near Nukusere, alt. 100-200 m, 29.x-2.xi.1953 (A, BISH, L, US); *Smith 4307*, Mba, vicinity of Nalotawa, eastern base of Mt Evans Range, alt. 550-600 m, 28.iv-17.v.1947 (A, BISH, L, US).

Distribution (Map 1)

V. vitilevuensis seems to be endemic to Fiji where it is known to occur on the Viti Levu Island. Further exploration is likely to expand its range of distribution to the neighbouring islands.

Comments

This species is the only known representative of *Viticipremna* in Fiji. Previously it has been misidentified and distributed in some herbaria as *Vitex quinata* var. *puberula*. The latter has more or less similar looking leaves and inflorescence, but may easily be identified by its calyx being shortly but distinctly 5-toothed; corolla 5-lobed, with tube about twice the length of calyx, lobes glabrous (not villous-pubescent) on the inner surface; stamens and style exserted. The occurrence of *Vitex quinata* var. *puberula* in Fiji was apparently based by Moldenke on some of A.C. Smith's collections cited here. Otherwise, this taxon has not been recorded from Fiji in any available flora of that region.

The present species was first recorded by Moldenke (1951) as *Vitex quinata* var. *puberula*. Subsequently, when Moldenke (1982, 1982A, 1982B) regarded the genus *Viticipremna* synonymous to *Vitex*, he renamed this species as *Vitex turczaninowii* f. *puberula* (H.J. Lam) Mold. In both places, the basionym for the variety and/or forma was *Vitex heterophylla* Roxb. var. *puberula* H.J. Lam (1919). The syntypes of Lam's variety did not include specimens from Fiji, and such specimens were wrongly identified by Moldenke as variety or forma *puberula*. They are now described here as a separate species. Although Moldenke (1982A) did not cite any specimen, it is clear from his identification on the herbarium sheets that he mistakenly included the Fijian elements in the forma *puberula*.

Affinities

As mentioned in key characters, *V. vitilevuensis* is closely related to *V. queenslandica*. Nevertheless, *V. vitilevuensis* may easily be distinguished by its calyx being truncate and pubescent outside, corolla-tube scarcely longer than calyx, anterior corolla lobe villous on the inner surface, stamens and style completely included, filaments up to 1.5mm long and anthers more or less 0.5 mm long. The stamen size is about half that of *V. queenslandica*.

V. vitilevuensis is also allied to *V. tomentosa* in its calyx being pubescent and glandular outside, anterior corolla lobe villous on the inner surface, ovary glandular and style included. However, *V. tomentosa* can readily be identified by its leaves being densely pubescent-tomentose; cymes sessile, arranged in distant verticillate clusters; calyx distinctly 4-lobed; corolla-tube twice the length of calyx, and filaments 2.5-3.5 mm long.

4. **Viticipremna philippinensis** (Turcz.) H.J. Lam, Bull. Jard. Bot. Buitenz. 3, 3 (1921) 47; Mold., Résumé Verben. etc. (1959) 185, 191, 339, 382, 390, 391; Fifth Summary Verben. etc. 1 & 2 (1971) 319, 329, 610, 716, 730, 732; Sixth Summary Verben. etc. (1980) 309, 319, 410; Phytologia 50, No. 4 (1982) 253, 267, 270.

Lectotype: *Cuming 1294*, Insullae Philippinae, 1841 (MEL, lectotype designated here; BM!, K—2 spec.!, NY! PNH n.v., —isolectotypes).

Premna philippinensis Turcz., Bull. Soc. Nat. Mosc. 36 (1863) 215, basionym.

Type: *Cuming 1294*, Insulae Philippinae, 1841 (BM!, K!, MEL!, NY!, PNH n.v., —syntypes). *Cuming 1172*, loc.cit., possibly 1841 (NY photo!, PNH n.v., syntype. Perhaps destroyed during the war). No other specimen of this collection was available for examination).

Gumira philippinensis (Turcz.) Kuntze, Rev. Gen. Pl. 2 (1891) 5O8.

Type: As for *Premna philippinensis* Turcz.

Vitex turczaninowii Merr. in Govt Lab. Philip. 35 (1906) 77; Philip. J. Sc. l, Suppl. 1 (1906) 121; Enum. Philip. Fl. Pl. 3 (1923) 397; Mold., Phytologia 49, No. 5 (1981) 457; Phytologia 50, No. 4 (1982) 253, 267, 270; Phytologia 51, No. 4 (1982) 274, in obs.

Type: As for *Premna philippinensis* Turcz.

Viticipremna turczaninowii (Merr.)H.J. Lam, Verben. Malay. Archip. (1919) 162.

Type: As for *Premna philippinensis* Turcz.

Typification

V. philippinensis is based on H. Cuming's collection nos 1172 and 1294 from the Philippines. Since the original author (N. Turczaninow) did not choose a holotype, it is, therefore, desirable to select a lectotype for this name. Of all the available syntypes, a duplicate of *Cuming 1294* in Herb. MEL is particularly complete and well preserved, and is, selected here as the lectotype for this species.

Description (Fig. 4)

Shrub or small tree "9-28" m tall (see Comments). *Stem*: trunk with bark rather fluted, grey, soft-barked; branchlets quadrangular, minutely ferruginous-puberulous. *Leaves* 3-6 (-7)-foliolate; leaflets petiolulate, lanceolate to narrowly elliptic-lanceolate, entire, with long acuminate apex, cuneate at the base, (6-) 8-15 (-17) cm long, (2.5-) 3-6 (-7.5) cm broad, chartaceous, glabrous, with some little scales above and reddish-brown glands beneath; pairs of nerves (7-) 8-12; petioles minutely ferruginous-puberulous, 5-11 cm long; petiolules minutely ferruginous-puberulous, (0.5-) 1-2.5 (-3) cm long. *Inflorescence* terminal, ferruginous-puberulous, 12-25 cm long, 15-30 cm wide; cymes pedunculate, arranged in more or less pyramidal panicles; lateral primary peduncles 2.5-6 cm long; pedicels densely ferruginous-pubescent, glandular, (1-) 2-4 (-5) mm long; bracts minute, caducous. *Calyx* tubular, cylindrical, truncate, glandular and densely ferruginous-pubescent outside; glabrous inside, 2-3 mm long, 1.5-2 mm in diameter at the top, persistent and accrescent in fruit. *Corolla* pale-yellow, 4-lobed in the upper half, tubular below, densely glandular and puberulous outside except the margins of the lobes, villous inside the tube near the insertion of the stamens; tube cylindrical, about twice the length of calyx, glabrous in the lower part, 3.5-5 mm long, 1.5-2.5 (-3) mm in diameter; lobes broadly elliptic-ovate or elliptic-oblong, obtuse, 2-4 (-5) mm long, 1.5-2 (-3) mm broad, the anterior lobe somewhat larger than the others. *Stamens* much exserted, didynamous, inserted in the middle part of the corolla-tube; filaments filiform, glabrous, somewhat villous at the base, the anterior pair longer, 5-9 mm long, the lateral pair 4-7 (-8) mm long; anthers more or less elliptic-oblong in outline, lobes oblong, free and divergent in the lower half, more or less 1mm long, 0.5 mm broad. *Ovary* globular or broadly pyriform, glabrous, 1-1.5 mm in diameter; style much exserted beyond the corolla-lobes, glabrous, filiform, 6-11 mm long; stigma distinctly 2-fid. *Fruit* globular-ellipsoid or somewhat pyriform, glabrous, 5-7 mm long, 5-6 mm in diameter; persistent calyx expanding to (5-) 6 mm in diameter.

Specimens examined

PAPUA NEW GUINEA: *Paijmans 225*, Lower Morehead River at Long. 141° 30'E, Western District, Papua, 13.viii.1967 (CANB, LAE). *Paijmans 418*, Agu River branch of the middle Fly River at Lat. 07° 04'S, Western District, Paua, 2.x.1967 (CANB). *Pullen 7524*, Morehead River at Long.141° 30'E, Western District, Papua, 14.viii.1967 (CANB).

INDONESIA: IRIAN JAYA: *Koster B.W. 1121*, Res. Ransiki Oransbari, 23.ix.1955 (BRI, CANB, L). *Kostermans 274*, Manokwari, 20.viii.1948 (BO, BRI, L, LAE). *Schram B.W.1965*, loc. cit., 19.x.1955 (CANB, L). MOLUCCAS: *Tangkilisan 200*, Morotai, Tobelo, North Totodokoe primary forest, 10.vi.1949 (BO, BRI, L, LAE).

PHILIPPINES: *Ahern FB 1127 & 2961*, Province of Rizal, Luzon, iv.1905 (BO, K, NY, PNH n.v.); *Alambra & Borromeo FB25884*, Bataan Prov., Luzon. -vii.1916 (A, BRI, GH). *Bartlett 15339 & 15374*, Kay Ungulan, near Teresa, Rizal Province, Luzon, 18.viii.1935 (A, PNH). *Bawan FB24194*, Bataan Prov. Luzon, -v.1915(A). *Canicosa s.n.*, Mt Makiling, Laguna Prov. Luzon, 10.v.1949 (PNH 9705). *Clemens s.n.*, Camp Keithley, Lake Lanao, Mindanao, vi.1907 (BO, PNH n.v.). *Clemens s.n.*, loc. cit., vii.1907 (BO—2 spec., PNH n.v.). *Conklin 333*, Mt Yagaw, Mindoro, 5.viii.1953 (A, L, PNH 18634; *Cuming 1173*, loc. incert., perhaps near Manila,1841 (A,BM, K, MEL). *Cuming 1294*, loc.cit., 1841 (BM, K—2 spec., MEL,NY, PNH n.v., —syntypes). *Curran FB 5837*, Zambales Prov., Luzon, -i.1907 (BR, PNH n.v.). *Curran FB 10639*, Camarines Prov., Luzon, vi.1908 (BR, BRI, PNH n.v.). *Curran FB 10505*, Sorsogon Prov., vi.1908 (BR). *Merrill & Darling FB 94049*, Prov. of Ilocos Sur, Luzon, -xi.1908 (PNH). *Elmer 16693*, Mt Bulusan, Sorsogon Prov., vii.1916 (A, BM, BO, K, NY, PNH). *Penas FB26677*, Cagayan Prov., Luzon, -v.1917

Fig. 4. *Viticipremna philippinensis* (Turcz.) H.J. Lam (A-F, *Cuming 1294*: MEL, lectotype; G, *C.A. Wenzel 3430*: BR). A, flowering branch; B, cyme; C, flower; D, flower vertically cut open showing androecium and gynoecium; E, ovary; F, transverse section of ovary; G, fruit with persistent calyx.

(A, PNH). *Ramos 382*, Antipolo Prov., Rizal, -vi.1910 (PNH, Z—2 spec.). *Merrill 2839*, Bosoboso, Rizal Prov., vii.1903 (K, PNH); *Ramos 1410*, Morong, Rizal Prov., Luzon 1906 (BO, GH, K, PNH). *Ramos & Edano BS45318*, Casiguran, Tayabas Province, Luzone, v-vi.1925 (BO, NY, PNH n.v.). *Quisumbing & Rosario s.n.*, Calayan Island, -v.1961 (PNH). *Sulit 1626*, Mt Makling, Laguna Prov., Luzon, 12.v.1947 (A, PNH). *Sulit & Conklin PNH 17715*, Mt Yagaw, Mindoro Island, v-vi.1953 (A, BM, L, PNH). *Wenzel 2760*, Suringao, 1.vi.1927 (B). *Wenzel 2563*, Surigao, 25.vi.1927 (BR, NY). *Wenzel 3430*, loc. cit., 25.vii.1928 (BR, NY). *Wenzel 809*, Leyte Island, 1.vi.1914 (A, BM). *Wenzel 966*, loc. cit. 1.vii.1914 (A, BM). *Wenzel 1333*, loc. cit. 2.v.1915 (A, BM). *Wenzel 1399*, loc.cit. 30.v.1915 (A, BM, NY). *Wenzel 2523*, Surigao, 9.iv.1927 (NY).

Distribution (Map 1)

V. philippinensis is known to occur in Papua New Guinea, Indonesia and the Philippines. In Papua New Guinea, this species is recorded from the Western District of Papua along the southern part of the Morehead River and the Fly River. Distribution in Indonesia is in the north-western part of Irian Jaya around Manokwari, and on Morotai Island in the Moluccas. In the Philippines, it has been collected from Calayan, Leyte and Mindoro Islands, and several places on Luzone and Mindanao Islands. In addition to the above localities, Moldenke (1959, 1971, 1980) and Merrill (1923) have recorded it from Batan and Ticae Islands in the Philippines. Moldenke (1959, 1971, 1980) has also reported its occurrence in Java, Indonesia. In Phytologia Memoirs II, Moldenke (1980) also recorded it from Kalimantan formerly, Dutch Borneo.

Comments

Merrill (1906) regarded *Premna philippinensis* Turcz. as belonging to the genus *Vitex*, and gave it a new name *Vitex turczaninowii*. He did not base it on *P. philippinensis* Turcz. because the epithet *philippinensis* was already occupied for a different species of *Vitex*. Nevertheless, he cited both the types of *P. philippinensis* and seven other collections under *Vitex turczaninowii* Merr. About the types, Merrill (1906) said that "this species which belongs in *Vitex*, rather than in *Premna*, was based on Nos 1172 and 1294 of Cuming's Phillippine collection, both these numbers being represented in the herbarium of this Bureau". During the present investigation, however, no duplicates of these numbers were found in the herbarium of the Bureau, presently the Philippine National Herbarium (PNH). It seems as if they were possibly destroyed in the war. In the same place, Merrill (1906) also mentioned that "in addition to the two numbers of Cuming's Philippine collection referred by Turczaninow to this species, it is apparently well represented also by No. 1173 Cuming, and . . ." In 1951, Merrill annotated Cuming's 1173 in the BM as the type of *Viticipremna philippinensis* (Turcz.) H.J. Lam. Actually, Turczaninow (1863) did not cite in the protologue Cuming's No. 1173, therefore, it should not be regarded as a type. Merrill's determinavit label gave the impression that he lately accepted the genus *Viticipremna*, but he made a mistake in labelling *Cuming 1173* as the type. During present studies, Cuming's 1172 and 1173 were found to be fairly identical collections of the same species. It is very likely that they may have been gathered simultaneously from the same plant, but as no. 1173 was not mentioned in the original description the specimen cannot be regarded as a type.

Several collections of this species have been identified by others as *Vitex quinata* (Lour.) F.N. Will. It is sometimes rather difficult to distinguish between these two species without critically examining their flowers.

The height of this species was given for only two collections. Therefore, the range of height mentioned in the present description may not be accurate.

Affinities

V. philippinensis is closely related to *V. novae-pommeraniae* in its branchlets and inflorescence being shortly ferruginous-pubescent, calyx glandular and densely pubescent outside, stamens and style much exserted above the corolla-lobes; ovary not glandular. However, *V. philippinensis* may readily be distinguished by the key characters. *V. philippinensis* is also related to *V. queenslandica* in having more or less similarly shaped leaves and inflorescence. For distinguishing characters, see "affinities" under the latter.

5. **Viticipremna novae-pommeraniae** (Warb.) H.J. Lam, Verben. Malay. Archip. (1919) 163; Bull. Jard. Bot. Buitenz 3, 3 (1921) 47; Mold., Résumé Verben. etc. (1959) 202, 204, 387; Fifth Summary Verben. etc. 1 & 2 (1971) 338, 340, 724, 732; Phytologia 31, No. 5 (1975) 391; Sixth Summary Verben. etc. (1980) 328, 329, 368, 460; Phytologia 50, No. 4 (1982) 255, 267, 270.

Lectotype: *O. Warburg 21140*, in the ravines of Raluan on the Gazelle-Peninsula of Neu Pommern (New Britain), iv-vi.1889 (A, lectotype designated here; BM, B n.v.—isolectotypes).

Vitex novae-pommeraniae Warb., Engl. Bot. Jahrb. 13 (1891) 429, *basionym*; Schumann & Lauterb., Fl.D. Südsee (1901) 524; Mold., Phytologia 50, No. 4 (1982) 255, 267, 270.

Type: As for *Viticipremna novae-pommeraniae* (Warb.) H.J. Lam.

Clerodendron novae-pommeraniae (Warb.) Schumann, Fl. Neu Pomm. (1898) 145, based on *Vitex novae-pommeraniae* Warb.; Mold., Résumé Verben. etc. (1959) 204; Fifth Summary Verben.etc. 1 (1971) 339, 452; Sixth Summary Verben. etc. (1980) 329, *syn. nov.*

Type: As for *Viticipremna novae-pommeraniae* (Warb.) H.J. Lam.

Vitex quinata var. *puberula* (H.J. Lam) Mold., Phytologia 49, No. 5 (1981) 458-459, p.p., quoad spec. *Conn & Katik LAE 66035.*

Typification

V. novae-pommeraniae is based on O. Warburg's collection no. 21140 from New Britain. Since Warburg did not choose a holotype, it is desirable to select a lectotype for this name. Of all the available syntypes, a duplicate in Herb. A is found to be particularly complete and well preserved. It is, therefore, selected here as the lectotype for this species.

Description (Fig. 5)

Tall shrub or tree, (7.5) 12-27 (-33.5) m tall. *Stem*: trunk with outer bark light grey-brown, peeling in vertical strips, bole 6-15 m high, (12-) 20-76 (-120) cm in diameter at breast height; branchlets quadrangular, minutely ferruginous-pubescent. *Leaves* 4-5-foliolate, sometimes 3-foliolate; leaflets palmately arranged, petioluled, ovate, ovate-oblong or ovate-lanceolate, entire, with narrow acuminate apex, unequally obtuse or subtruncate at the base, rarely cuneate, (4-) 6-13 (-18) cm long, (2.5-) 3.5-5.5 (-9) cm broad, thinly chartaceous, glabrous excepting some hairs on and near the midrib; pairs of nerves 8-11; petioles minutely ferruginous-pubescent, (3-) 5-12 (-19) cm long; petiolules minutely ferruginous-pubescent, the lower two 0.2-1 cm long, the remaining (i.e. the upper) 1-2.5 (-3.5) cm long, the terminal petiolule always the longest. *Inflorescence* terminal, ferruginous-tomentose, 8-20 (-30) cm long, 6-15 (-22) cm wide; cymes pedunculate, di- or trichotomously branched, arranged in more or less pyramidal panicles; the basal lateral primary peduncles (3-) 4-6 (-8) cm long; flowers shortly pedicellate; pedicels densely ferruginous-pubescent, glandular, 1-3 (-4) mm long; bracts minute, caducous. *Calyx* tubular or cup-shaped, cylindrical, truncate, glandular and densely pubescent outside,

Fig. 5. *Viticipremna novae-pommeraniae* (Warb.) H.J. Lam (A-G, *Henty, Coode & Cropley NGF 29143*: NSW). A, flowering branch; B, cyme; C, flower; D, flower vertically cut open showing androecium and gynoecium; E, ovary; F, transverse section of ovary; G, fruit with persistent calyx.

glabrous inside, 2.5-3 mm long, 2-2.5 mm in diameter at the top, persistent and accrescent in fruit, expanding to 7 mm in diameter. *Corolla* creamy or pale-yellow, with purple streaks on the lower lip and inside the throat, somewhat 2-lipped, 4-lobed in the upper half, tubular below, glandular and densely fulvous-pubescent outside excepting the lower half of the tube and the margins of the middle-lobe of the lower lip, villous inside in the upper part of the tube and at base of the middle lobe of the lower lip; tube more or less cylindrical, about twice the length of calyx, glabrous in the lower half, 4.5-6 mm long, 2.5-3 mm in diameter at the top; lower lip 3-lobed, lobes subequal, with the middle lobe somewhat larger than the others, narrowly elliptic-oblong, obtuse, (2-) 2.5-3 (-4.5) mm long, 1.5-2 (-3) mm broad; upper lip usually entire, sometimes more or less 2-lobed, elliptic-orbicular or broadly elliptic-ovate, 3-3.5 (-4) mm long, 2.5-3.5 mm broad. *Stamens* much exserted, didynamous, inserted in the upper part of the corolla-tube; filaments filiform, glabrous excepting a few villous hairs near the base, the anterior pair longer, 6-7 mm long, the lateral pair 5-6 mm long; anthers more or less elliptic-oblong in outline, lobes oblong, free and divergent in the lower half, more or less 1 mm long, 0.5 mm broad. *Ovary* globular-obovoid, glabrous, 1.5-2 mm long, 1.3-1.5 mm broad; style much exserted beyond the corolla-lobes, glabrous, filiform, 9-10 mm long, stigma unequally 2-fid. *Fruit* globose to obovoid, glabrous, 5-9 mm long, 5-8 mm in diameter, green when immature, purple-black when ripe, turning black on drying.

Specimens examined

PAPUA NEW GUINEA: Conn & Katik LAE 66035, Sisilia River area, subdist. Finschhafen-Umboi Isl. dist. Morobe, 27.ix.1974(A, BISH, CANB, E, K, L, LAE, M, PNH, QRS, SYD, US). *Coode, Cropley & Katik NGF 29610*, c. 26 miles from Kavieng, New Ireland, 24.i.1967 (CANB, K, L, LAE). *Coode, Sands & Lelean NGF 46112*, c. 8 miles inland, Namatanai Sub-dist., New Ireland, 11.ii.1970 (CANB, K, L, LAE). *Floyd 6646*, Keravat, New Britain, 28.xii.1954 (A, BM—2 spec., BRI, K, LAE, MEL, NSW—2 spec.). *Hartley TGH 10082*, Bewapi Creek, c. 4 miles W of Lae, 28.iii.1962 (BRI, CANB, LAE). *Hartley TGH 11350*, between Busu and Butibum Rivers, c. 10 miles N of Lae, 4.iii.1963 (BRI, CANB, LAE). *Hartley TGH 11350A*, Lae Botanic Gardens, 5.viii.1964 (BRI, CANB, LAE). *Havel & Kairo NGF 17325*, Gnalan Gumbum, Lae Subdist., 20.xi.1962 (A, BO, BRI, CANB, K, L, LAE, SING). *Hellwig 390*, near Butaveng, 8.iii.1889 (K). *Henty, Coode & Cropley NGF 29143*, Busu River, near Lae, Morobe Dist., 21.xii.1966 (A, BO, BISH, BRI, CANB, K, L, LAE, NSW, SING). *Hepplethwaite NGF 546*, Los Negros Island, Manus dist., Admiralty Islands, -.ii.1945 (A, BRI, LAE). *Mair NGF 1852*, Jacquinto Bay, New Britain, -.iv.1945 (A, BRI—2 spec., CANB, K, LAE, NSW). *Millar NGF 9782*, Lae Botanic Gardens, Morobe Dist., 30.i.1959 (A, BRI, K, LAE, NSW). *Womersley NGF 19135*, Gnalangumbum, 6 miles N of Lae, Morobe Dist., 11.ii.1964 (A, BISH, BO, BRI, CANB, K, L, LAE, NSW, PNH, SING, UH, US). *Womersley NGF 37105*, Sankwep Ridge near Busu, Lae Subdist., 22.xi.1967 (A, BISH, BO, BRI, CANB, K, L, LAE, NSW, PNH, SING). *Womersley & McEwin NGF 37425*, Sankwep logging area, Lae Subdist., 9.i.1969 (A, BO, BRI, CANB, K, L, LAE).

Distribution (Map 1)

V. novae-pommeraniae is endemic to Papua New Guinea where it has been recorded from the north-eastern part of the country. On the mainland, it is known to occur around the township of Lae, and outside it is reported from Admiralty Island, Bismarck Islands, New Britain and New Ireland.

Comments

A collection by Henty, Coode & Cropley (no. NGF 29143) has a few flowers with the upper corolla-lip somewhat 2-fid or shortly 2-lobed at the top. Most flowers of this collection, however, have an undivided upper corolla-lip. The short division in the upper corolla-lip may be another indication of its close relationship with *Vitex* in which the upper corolla-lip is often distinctly 2-lobed.

The ovary is generally glabrous and non-glandular but in the collection by Coode, Cropley & Katik (no. NGF 29610), a few scattered yellow glands are found on some ovaries. These glands seem to disappear in more mature ovaries or at least in the fruiting stage.

Moldenke (1959, 1971, 1980) recorded this species from Irian Jaya, Indonesia. During present investigation, however, the occurrence of this species in any part of Indonesia has not been confirmed.

According to collector's notes this is found chiefly in the logging areas of lowland forests. It is also grown at Lae Botanic Gardens in New Guinea.

The specimen with the largest organs was collected by K. Mair (no. NGF 1851) from New Britain. It has leaflets 18 cm by 9 cm, petioles up to 19cm, petiolules up to 3.5cm and inflorescence 30 cm by 22 cm in outline.

Affinities

V. novae-pommeraniae is closely related to *V. philippinensis*. For detail see "affinities" under the latter.

Warburg (1891), who originally described it as a *Vitex* species, considered it closely related to *Vitex acuminata* but distinguished it by the size and form of the leaves, length of petiolules, size of the fruit and the tomentum of the fruiting calyx. The leaflets in *V. acuminata*, however, are much thinner and cuneate towards the base, petiolules glabrous, fruit somewhat larger and calyx-tube toothed at the top and without glands outside. *V. novae-pommeraniae* has also been confused with *Vitex quinata* from which it may easily be distinguished by its leaflets being unequally obtuse or subtruncate at the base, calyx-tube truncate, corolla mainly 4-lobed and ovary non-glandular.

Acknowledgements

The author is grateful to Dr J.P. Jessop for comments on the draft of this manuscript and for translation into Latin the diagnoses of the new species; to Dr H.N. Moldenke for supplying references relevant to this work; to Dr H.R. Toelken for useful suggestions; to Mr G.R.M. Dashorst for preparing the illustrations; to Miss Barbara Welling for typing the manuscript.

Thanks are also due to the Directors/Curators of the following institutions for the loan of herbarium specimens: A, B, BM, BO, BR, BRI, CANB, CBG, DNA, GH, JCT, K, L, LAE, MEL, NSW, NT, NY, PERTH, PNH, PR, QRS, SING, SYD, Z.

References

Airy Shaw, H.K. (1973). J.C.Willis's "A Dictionary of the Flowering Plants and Ferns". 8th edn (University Press: Cambridge).

Allan, H.H. (1961). Verbenaceae. "Flora of New Zealand". Vol. 1: 959-960. (R.E. Owen, Govt Printer: Wellington).

Lam, H.J. (1919). "The Verbenaceae of the Malayan Archipelago together with those from the Malayan Peninsula, the Philippines, the Bismarck-Archipelago, and the Palau-Marianne and Caroline-Islands". (M. De Waal: Groningen).

Lam, H.J. & R.C. Bakhuizen van den Brink (1921). Revision of the Verbenaceae of the Dutch East-Indies and surrounding countries. *Bull. Jard. Bot. Buitenz.* Ser. 3, Vol. 3: 1-116.

Merrill, E.D. (1906). Notes on Cuming's Philippine Plants in the herbarium of the Bureau of Government Laboratories. *Bur. Govt Lab. Publ. Philip.* No. 35: 62-77.

Merrill, E.D. (1923). Verbenaceae. "An Enumeration of Philippine Flowering Plants". Vol. 3: 380-408. (Bureau of Science: Manila).

Moldenke, H.N. (1951). Notes on new and noteworthy plants. *Phytologia* 3: 489.

Moldenke, H.N. (1959). "A résumé of the Verbenaceae, Avicenniaceae, Stilbaceae, Symphoremaceae, and Eriocaulaceae of the world as to valid taxa, geographic distribution and synonymy". (H.N.Moldenke: Mountainside, New Jersey).

Moldenke, H.N. (1971). "A fifth summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Dicrastylidaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the world as to valid taxa, geographic distribution, and synonymy". Vol. 1 & 2. (H.N. Moldenke: Wayne, New Jersey).

Moldenke, H.N. (1980). "Phytologia Memoirs II. A sixth summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Chloanthaceae, Symphoremaceae, Nyctanthaceae, and Eriocaulaceae of the world as to valid taxa, geographic distribution and synonymy". (H.N. Moldenke & A.L. Moldenke: Plainfield, New Jersey).

Moldenke, H.N. (1982). "A sixth summary of the Verbenaceae, Avicenniaceae, Stilbaceae, Chloanthaceae, Symphoremaceae, Nyctanthaceae and Eriocaulaceae of the world as to valid taxa, geographic distribution and synonymy. Supplement 1". *Phytologia* 50(4): 233-270.

Moldenke, H.N. (1982a). Notes on new and noteworthy Plants. CLVII. *Phytologia* 51(2): 162-163.

Moldenke, H.N. (1982b). Additional notes on the genus *Vitex* XXXIV. *Phytologia* 51(4): 246-290.

Munir, A.A. (1982). A taxonomic revision of the genus *Callicarpa* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 6(1): 5-39.

Munir, A.A. (1984). A taxonomic revision of the genus *Premna* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 7(1): 1-43.

Munir, A.A. (1984a). A taxonomic revision of the genus *Gmelina* L. (Verbenaceae) in Australia. *J. Adelaide Bot. Gard.* 7(1): 91-116.

Warburg, O. (1891). Beitrage zur Kenntnis der Papuanischen Flora. *Bot. Jahrb.* 13: 426-429.

Index to Scientific

Names

New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked refer to figures and maps.

J. Adelaide Bot. Gard. 7(2): 201-206 (1985)

THE REINSTATEMENT OF *SOLANUM SHANESII* F. MUELL. SECTION *LYCIANTHES* (SOLANACEAE) WITH DISCUSSION OF ITS SIGNIFICANCE.

D.E Symon

Waite Agricultural Research Institute,Glen Osmond, South Australia 5064.

J.R. Clarkson

Botany Branch, Department of Primary Industries, Mareeba, Queensland. 4880.

Abstract

New collections of *Solanum* from northern Queensland have enabled the problem of the indentity of *S. shanesii* to be resolved. This species belongs to *Solanum* sect. *Lycianthes* (Dun.) Wettst. which has not previously been recorded for Australia. The closest relatives of *S. shanesii* are found in Central America. A further collection of *Solanum* sect. *Lycianthes* from Queensland may represent a new species.

Introduction

Solanum shanesii F. Muell., Fragm. 6 (1868) 144, was based on fruiting collections by Dallachy and O'Shanesy from Queensland. Three collections remain at MEL. The first, MEL 12403, has four labels, (a) "'B' Solanum shanesii ferd. v. Mueller Rockhampton;" (b) "*Solanum shanesii* F. v. M. 435 Solanum Mores Creek fruit red": (c) "17th March 1863"; (d) "*Solanum shanesii* ferd v. Mueller Rockhampton D". There is a duplicate of this collection at K labelled (a) "Flora Australiensis named by Mr. Bentham Vol. IV, Page 448, *S. shanesii* F.M.", (b) "*Solanum shanesii* F. Mueller Rockhampton Dallachy Herb. F. Mueller 1868". The second collection MEL 12404 is labelled (a) "*Solanum shanesii* F. Muell. Fragm. VI 144 (1868) Rockhampton, Q'land, O'Shanesy 25.2.1868" and (b) "No. 6 ser. 1, Solanum erect and slender 6-8 feet bark light coloured and slightly blistered bark berry shining red ½" diameter 2 celled rare Rockh. R. O'Shanesy 25.2.1868 not prickly". The sheet MEL 12404 was proposed as lectotype by Symon (1981b).

The original collections lack flowers and were placed in *Capsicum* (Symon, 1981 a, b) because of the shallow lobing of the fruiting calyx; he believed them to be early feral plants, the absence of flowers making it difficult to identify with certainty. The suggestion that the collections might be a *Capsicum* is supported by the shallow lobing of the calyx and lack of teeth below the rim. There has been no recent fertile collections until those described below.

In December 1981 a flowering and fruiting specimen was collected by J.R. Clarkson (*4217*) and in March 1983 further good material was gathered (*Clarkson 4585, 4586*).

Affinities of Solanum shanesii

The species is clearly distinctive among Australian *Solanum* and has no apparent close relatives. Comparing it with other treatments of the genus showed affinities to section *Lycianthes*: this was suggested by the geminate leaves, simple hairs, axillary pedicellate inflorescence, cupulate calyx with scarcely developed lobes, rather thick, fleshy, strongly reflexed corolla lobes and slightly unequal anthers. As such it would constitute the first record for this section in Australia.

The status of Lycianthes

The genus *Lycianthes* has been recognised as a segregate from the very large group *Solanum*. However, even in recent publications the acceptance of the genus is by no means general. The only monograph on *Lycianthes* as a genus was by the specialist on the Solanaceae, Bitter (1920). His use of generic status was followed by D'Arcy (1973), Gentry and Standley (1974) and Deb (1980). Other specialists in the family, including Morton (1944, 1976), Macbride (1962) and Hunziker (1979) recognised *Lycianthes* only at lower taxonomic rank, within *Solanum*. Because there are no features which reliably distinguish *Lycianthes* from *Solanum* I favour the latter treatment. However for discussion the sectional names used by Bitter (1920) will be followed. The species of *Lycianthes* in S.E. Asia belong to two sections of the subgenus *Polymeris* (Dun.). Bitter. Section *Asio-melanesia* Bitter typified by *L. biflora* (Lour.) Bitter, has two species in New Guinea and up to ten ill-defined and variable taxa in the rest of S.E. Asia. All of these may be excluded from comparisons with *S. shanesii* on the basis of growth habit, pubescence and calyx characters. The second group comprises subgenus *Cypellocalyx* Bitter with about 16 species in S.E. Asia and particular concentrations of species in New Guinea. All of these species may be excluded from comparisons with *S. shanesii* on the basis of growth habit, leaf shape, pubescence and calyx characters. However, these last taxa are more closely related than the previous group of species. All remaining taxa of *Lycianthes* occur in South America, Central America or Mexico. The great majority of the New World species may be readily excluded on the basis of growth habit, pubescence of calyx form except Bitter's subgenus *Polmeris* (Dun.) Bitter, section VII *Synantheroides* Bitter, which consists of six species from Mexico through Guatemala to Panama. Of these species the Queensland taxon seems most closely related to *L. synanthera* (Sendtn.) Bitter. Despite the name of the section and of the latter species, not all have anthers joined in a tube cf. *L. heteroclita* (Sendtn.) Bitter, *L. ceratocalycia* (Donn. Sm.) Bitter and *L. synanthera*.

Specimens of *L. synanthera* and the later described *L. escuintlensis* (Coult.) D'Arcy have been seen and a close relationship to *S. shanesii* appears evident. However, until more detailed morphological comparisons are made it is not possible to state the degree of affinity.

Chemical analysis of the leaves of *S. shanesii*, Ripperger *et al.* (1984) have shown that it contains the alkaloid soladulcidine. As this is known to occur in other species, e.g. *S. dulcamara* L., section *Dulcamara* Dumont, it does not in itself contribute to a separation of *Solanum* and *Lycianthes* though very little is known of the chemistry of the latter section.

Biogeographical significance

The apparent morphological relationship of *Solanum shanesii* reveals a fifth Australian species of the Solanaceae which can be considered discordant in the Australian flora in having close relations in the Mexico to Central America area. Previously *Datura leichhardtii* F. Muell. ex Benth., Haegi (1976), *Physalis minima* L., Symon (1981b), *Solanum callium* C.T. White ex R. Henderson (1977) and *Solanum erianthum* D. Don, Symon (1981a) have been noted.

Long distance dispersal of all five species is not considered likely. Neither *Datura leichhardtii*, *Solanum callium* nor *S. shanesii* have been recognised north of Australia or in any of the Pacific Islands. Both *S. erianthum* and *Physalis minima* were originally named from India and occur in the South East Asian tropics. Their dispersal to northern Australia by fruit pigeons or flying foxes from an early Spanish or Portuguese introduction from Central America is perhaps conceivable. I know of no confirmed records of early Portuguese/Spanish contacts with Queensland, but it is highly likely that they occurred.

Fig. 1. *Solanum shanesii* drawn from *Clarkson 4585, 4586* and photos.

Systematic treatment

Solanum shanesii F. Muell., Fragm. 6 (1868) 144.

Type citation: "Ad rivulos montium prope Rockhampton; Dallachy & O'shanesy."

Lectotype: *MEL 12404*, proposed Symon (1981b).

A tall shrub or small tree (4-) 6-7 (-8) m, trunk to 10-13 cm diam., branches brittle, bark with abundant lenticels, unarmed, indumentum of sparse simple, few celled hairs, slightly antrorse, apparently eglandular, concentrated at nodes, axils and young growth, glabrescent. *Leaves* (3.5-) 8 (-11) x (2.5-) 6 (-8) cm, ovate-acuminate, base rounded, oblique, extended in a narrow cuneate wing down petiole, often geminate, smaller leaf about 3/4 the size of larger, exposed leaves may have undulate margin and primary veins coloured purple; petiole (1-) 1.5 (-3) cm long. *Inflorescence* 1-2 (-3) pedicellate flowers from leaf axil in uppermost branches. *Flowers* of two kinds: apparently hermaphrodite, long-styled flowers which produce fruit and apparently male, short styled flowers which to not produce fruit. *Pedicel* c. 8 mm, gradually enlarged upwards. *Calyx* truncate with (4-) 5 short rounded lobes, acumens rarely developed. *Corolla* deeply stellate (4-) 5-partite, early flowers with a long style, late flowers with a short style (male), tube c. 2 mm long, lobes 7-8 mm long, elliptic, mid-portion relatively thick, margins (inter-acuminal tissue) narrow and slightly infolded, the whole strongly reflexed an anthesis, apex minutely pappillose and distinctly inflexed, bluish-purple to deep purple with an almost brown mid-vein on ageing. *Filaments* c. 1.5 mm long, triangular in shape and broadly flattened towards base. *Anthers* 4-5 mm long, oblong, only slightly tapered, opening by apical pores, well exserted, erect in a cone, in male flowers the lower anther on a longer filament so that it exceeds others by 1-1.5 mm. *Ovary* c. 1.3 mm diam. ovoid, glabrous. *Style* of fruiting flowers c. 6 mm long, simple, erect, glabrous, exceeding anthers, stigmatic region attentuate, swollen and spindle shaped possibly bifid or partially so, male flowers with style 4 mm long, not exceeding anthers. *Fruiting pedicel* 2-3.5 cm long, distinctly enlarged distally; calyx patelliform. *Berry* 1-1.7 cm diam. nearly globular, bright shiny red. Seeds 3.5 mm diam., flattened, margin distinctly thickened, surface shallowly reticulate, buff coloured.

Chromosome number: n = 12, counted by P. Ellis from *Clarkson 4585*, voucher ADW.

Distribution

Queensland, Cape York. Common understorey element of deciduous or semideciduous closed forest pockets in the Byerstown Range area. Known also from several other locations on Cape York and from the Rockhampton area. The disjunction between the early collections from near Rockhampton and later collections much further north is inexplicable.

Note

Another collection belonging to section *Lycianthes*, *Heatwole s.n.*, 24.vii.1969, BRI has been found at Restoration Rock, near Cape Weymouth, 12° 38′ Lat., 143° 26′ Long., Qld. It appears to be different from *S. shanesii* and more material is required.

The species may be inserted into the key in Vol. 29 of 'Flora of Australia' as follows:

p. 76 rewrite lead 3 as follows—

3 Inflorescence an axillary cluster of pedicellate flowers, peduncle absent or scarely developed

3a Corolla rotate, leaves elliptic, ripe berry (rare) drab yellow-green . . . *S. rantonnei*

3a Corolla stellate, leaves ovate-acuminate, ripe berry bright red . . . . *S. shanesi*

p. 77 rewrite lead 20 as follows—

20 Shrubs to 7 m

20a Flowers white, leaves lanceolate-elliptic, berry bright orange-red ..... *S. callium*

20a Flowers purple, leaves ovate-acuminate, berry bright red .... *S. shanesii*

Map 1. Queensland: Distribution of *S. shanesii.*

Specimens seen (all listed)

QUEENSLAND: *Dallachy 435*, 17.iii.1863, Mores Creek (? near Rockhampton). Fruit red. K, MEL. *O'Shanesy 6*, 25.ii.1868, Rockhampton. Solanum erect and slender 6-8', bark light coloured and slightly blistered, berry shining red, 2-celled, not prickly. MEL. *O'Shanesy s.n.*, 1.ii.1969, Rockhampton. A deciduous shrub, flowers blue, petals reflexed, anthers yellow. MEL. *Done s.n.*, 3.vii.1969, Hannibal Island near Shelbourne Bay, 11° 35′ Lat. 142° 56′ Long. (Leaves only). BRI. *Hyland 5222*, 10.vi.1971, Great Divide, S of Byerstown, 16° 00′ Lat. 144° 45′ Long. 450 m alt. Monsoon forest, shrub of small tree, conspicuous elongated lenticels on the trunk. (Leaves only). QRS. *Nicholson AF04776*, 23.xi.1972; Rocky knob just S of divide on Palmer River road, 16° 00′ Lat., 144° 00′ Long. 460 m alt. Dry scrub. QRS. *Hyland 8713*, 6.iv.1976, Lankelly Creek road, 13° 54′ Lat. 143° 15′ Long. 450 m alt. Monsoon forest—rainforest, shrub 1-2 m tall. (Leaves only, doubtful). QRS. *Godwin C881*, v.1980, Byerstown Range, ca 1.5 ml E of Highway. 16° 00′ Lat. 144° 50′ Long. Deciduous vine thicket on iron-rich chert ridge along Fault Line. Understorey shrub. QRS. *Hyland 11071*, 26.v.1981, Mutee Head near Bamaga, 10° 55′ Lat. 142° 15′ Long. alt. 20 m. Rainforest, shrub 2-3 m tall. (Leaves only). QRS. *Clarkson 4217*, 23.xii.1981, 11.8 km north of the Palmer River on the Peninsula Development road. 16° 01′ Lat. 144° 49′ Long. 450 m alt. A shrub to 4 m tall. A fairly common understorey plant. (BRI, QRS, PERTH, NT, K, MO, L, MEL, n.v.). *Clarkson 4585*, 14.iii.1983, 11.7 km north of the Palmer River of Peninsula Development road. 16° 01′ Lat. 144° 49′ Long. 450 m alt. Small pocket of low closed forest on rocky hillside. Tall shrub or small tree to 6-7 m tall. ADW (BRI, QRS, K, L, F, US, CANB, AD, MO, PERTH, MEL, NSW, n.v.). *Clarkson 4586*, 14.iii.1983, 11.7 km north of the Palmer River on Peninsula Development road. 16° 01′Lat. 144° 49′ Long. 450 m alt. Small pocket of closed forest on a rocky hillside. Small tree 6 m tall. On margin of forest. ADW, (BRI, QRS, K, L, n.v.). *Godwin C2416*, 7.vi.1983, Barrons Range, Kings Plain Station, SW of Cooktown. 15° 36.7′ Lat. 145° 04.5′ Long. 300 m alt. Semi evergreen mixed microphyll/notophyll vine forest on outcrop of limestone and metamorphic? rock adjacent to main limestone outcrop. 4 m shrub with crown at 1.5 m. QRS. *Clarkson 5131*, 31.i.1984, 11.7 km north of the Palmer River on Peninsula Development Road. 16° 01′ Lat. 144° 49′ Long. Closed forest pocket ADW (BRI, K, QRS, L, CANB, US, n.u.).

Acknowledgments

Thanks are due to Mr B.P.M. Hyland of QRS for the loan of specimens. Technical assistance for Mr J.R. Clarkson for field studies on Cape York Peninsula is supported by an Australian Biological Resources Study grant.

Bibliography

Bitter, G. (1920). Die Gattung *Lycianthes*. *Abh. Naturwiss. Vereine Bremen* 24: 292-520.
D'Arcy, W.G. (1973). Flora of Panama. Pt. IX Family 170, Solanaceae. *Ann. Missouri Bot. Gard.* 60: 573-780.
Deb, D.B. (1980). Enumeration, synonymy and distribution of the Solanaceae in India. *J. Econ. Tax. Bot.* 1: 33-54.
Gentry, J.L. & Standley, P.C. (1974). Flora of Guatamala X, Solanaceae. *Fieldiana: Botany*, 24: 1-151.
Haegi, L. (1976). Taxonomic account of *Datura L.* (Solanaceae) in Australia with a note on *Brugmansia* Pers. *Aust. J. Bot.* 24: 415-35.
Henderson, R.J.F. (1977) Notes on *Solanum* (Solanaceae) in Australia. *Austrobaileya* 1: 13-22.
Hunziker, A.T. (1979). South American Solanaceae: a synoptic survey. In: "The Biology and Taxonomy of the Solanaceae". Edit. J.G. Hawkes, R.N. Lester & A.D. Skelding. 49-85. (Academic Press: London).
MacBride, J.F. (1962). Flora of Peru, Solanaceae. *Field Mus. Nat. Hist. Bot. Ser.* 13(5): 1-267.
Morton, C.V. (1944). Taxonomic studies of tropical American plants. *Contr. U.S. Nat. Herb.* 29: 41-74.
Morton, C.V. (1976). A revision of the Argentine species of *Solanum*. *Acad. Nac. de Cienc. Cordoba.* 1-260.
Purdie, R.W., Symon, D.E. & Haegi, L. (1982). Solanaceae, 'Flora of Australia', Vol. 29. A.S. George, Editor. (Aust. Govt. Publ. Service: Canberra).
Ripperger, H., Schreiber, K., Symon, D. (1984). Soladulcidine from *Solanum shanesii*. *Pharmazie* 39: 125/.
Symon, D.E. (1981a). A revision of the genus *Solanum* in Australia. *J. Adelaide Bot. Gard.* 4: 1-367.
Symon, D.E. (1981b). The Solanaceous genera, *Browallia, Capsicum, Cestrum, Cyphomandra, Hyoscyamus, Lycopersicon, Nierembergia, Physalis, Petunia, Salpichroa* and *Withania*, naturalised in Australia. *J. Adelaide Bot. Gard.* 3: 133-166.

J. Adelaide Bot. Gard. 7(2): 207-215 (1985)

PLANT PORTRAITS

The printing of the following four illustrations in colour was made possible by special funding from The Friends of the Botanic Gardens of Adelaide Inc.

13. **Cheiranthera volubilis** Benth. (Pittosporaceae)

Cheiranthera volubilis Benth., F1. Aust. (1863) 128 ; J. Black, F1. S.Aust. edn 2 (1948) 394.

Illustration: Based on fresh material preserved under *R. Davies & W. Bushman 145*, from near junction of Church Road and West-End Highway, north from gate into Flinders Chase National Park, Kangaroo Island, 8.x.1983 (AD).

A glabrous twiner 20 cm to 1 m tall. *Stem* weak, slender, terete, branching chiefly at the base, usually purplish-brown, glabrous, papillose with flaky epidermis. *Leaves* erect, alternate, sometimes clustered at the node, sessile, linear, mucronate, strongly involute so as to appear almost terete, channelled on the upper surface and somewhat papillose, glabrous and with sparsely ciliate margins, 2-22 (-30) mm long, 0.5-1 mm broad. *Flowers* solitary, terminal, drooping from a lone slender peduncle; peduncle purplish, 1-5 cm long. *Sepals* 5, free, lanceolate, acute, greenish-blue with scarious margins, glabrous, glandular-viscid outside, 4-6.5 mm long, 1-1.5 mm broad. *Petals* 5, free, obovate, glabrous, deeply violet-blue, 14-15 mm long, ± 7 mm broad. *Stamens* 5, all curved towards one side of the flower; anthers conspicuously sulphur-yellow, longer than the filaments, narrowly oblong-ovoid, obtuse, ± 4.5 mm long, about 1 mm broad, opening by two apical pores; filaments violet-blue, flat, curved, glabrous, 3-3.5 mm long. *Ovary* superior, cylindrical, abruptly constricted at both ends, glabrous, 3-3.5 mm long, 1-1.5 mm in diameter; style subulate, glabrous, violet-blue, ± 4 mm long, stigma entire. *Fruit* not seen.

C.volubilis is endemic to Kangaroo Island, South Australia, where it is reported chiefly from the western and southern parts of the island. A detailed description of this species is provided here for the first time. The descriptions provided by Bentham (1863) and J.M. Black (1948) lack details. The publications of Bennett (1972, 1978) are the most recent references dealing with the genus *Cheiranthera*, but she describes mainly new taxa and did not mention *C. volubilis.*

This species is very similar to *C. parviflora* Benth. in its solitary flowers being borne on slender terminal peduncles. Nevertheless, *C. parviflora* can easily be distinguished by its leaves being much broader, flat and with slightly revolute or recurved margins and its comparatively smaller flowers. Moreover, *C. parviflora* is endemic to Western Australia while *C. volubilis* occurs only on Kangaroo Island in South Australia. *C. volubilis* is also closely related to *C. alternifolia* E. Bennett, but the latter can readily be identified by its twiggy branches and corymbose inflorescence.

According to field notes accompanying the specimens *R. Davies & W. Bushman 144, 155* (AD), this species occurs chiefly in sandy, silty or clayey soil with laterite. It has been collected from a 'gentle south-facing slope near crest of broad ridge of dissected plateau'. The species was found to regenerate in areas bulldozed or destroyed by fire. *C. volubilis* is found in association with low open shrubland of *Xanthorrhoea tateana* F. Muell. and *Caustis pentandra* R. Br. G. Jackson (*608 & 416* in AD) collected it from 'ironstone rubble under pine plantation'.

References

Bennett, E.M. (1972). New taxa and new combinations in Western Australian Pittosporaceae. *Nuytsia* 1(3): 266-269.
Bennett, E.M. (1978). New taxa and new combinations in Australian Pittosporaceae. *Nuytsia* 2(4): 184-199.
Bentham, G. (1863). Pittosporaceae. 'Flora Australiensis'. Vol 1: 109-128. (L. Reeve & Co.: London).
Black, J.M. (1948). Pittosporaceae. 'Flora of South Australia'. edn 2. Part 2: 393-395. (Govt Printer: Adelaide)

A.A. Munir
State Herbarium of South Australia
Adelaide 5000

Del. J. Morley
Gumeracha, South Australia 5233

14. **Acacia glandulicarpa** R. M. Reader (Leguminosae- Mimosoideae)

Acacia glandulicarpa F.M. Reader, Vic. Nat. 13: 146 (1897); Whibley, Acacias of South Australia (1980) 136.

Illustration: Based on fresh material preserved under *R. Davies & W. Bushman 517*, from Burra Creek Gorge, southern side c. 1 km west of end of road into gorge, c. 22 km from Robertstown, 29. vii. 1983 (AD).

Shrubs rounded, spreading, usually much branched, 1-2 m high, with dull olive-green foliage; branchlets grey-brown, terete, pubescent, marked with small raised phyllode bases. *Phyllodes* small, obliquely oblong-obovate to more or less elliptical, 5-12 mm long, 3-6 mm broad, erect, thick, rigid, glabrous, minutely glandular, 2-nerved with usually central nerve more prominent, lateral nerves somewhat anastomosing and few obscure, apex shortly mucronate. *Stipules* small, thick, almost deltoid, persistant. *Inflorescences* simple and axillary, solitary or twin, flower heads bright yellow, small 8-20 flowered; peduncles about as long as phyllodes. *Calyx* 5-lobed, lobes about as long as the tube, ciliate, somewhat clothed with whitish shining hairs. *Petals* glabrous, oblong-ovate, slightly oblique, rather acute, with a broad prominent nerve. *Legumes* narrowly oblong, 1.5-3 cm long, 2-3 mm broad, straight or curved, viscid and covered with glandular shining hairs. *Seeds* depressed oblique in legume obovoid ellipsoid, funicle short folded under seed and thickening gradually into an elongated aril. Flowering time: July-October.

Acacia glandulicarpa has a disjunct distribution. The main occurrence is as scattered populations in the West-Wimmera, Victoria with the largest populations in the Gerang-Gerung- Kiata area (Stowe J. (1982) *Vic. Nat.* 99: 52-65).

In South Australia a small population of *A. glandulicarpa* occurs in the Northern Lofty Region on north-west facing slopes on skeletal soil with slate and shale. *A. glandulicarpa* was first recorded in September 1966 from this area by C.D. Boomsma (AD 96637002). Recently R. Davies and W. Bushman searched the area and observed 18 plants with no seedlings apparent.

The vegetation is low shrubland associated with *Eucalyptus socialis* F. Muell. ex Miq., *E. brachycalyx* Blakely and *Callitris preissii* Miq. Other acacias observed in the near and surrounding area are *Acacia brachybotrya* Benth., *A. oswaldii* F Muell., *A. calamifolia* Sweet ex Lindley, *A. ligulata* Cunn. ex Benth., *A. pycnantha* Benth.

Acacia glandulicarpa is similar in habit and related to *A. rotundifolia* Hock. but the latter differs in having one main nerve on the phyllode and a spirally coiled more or less glabrous legume.

About one-third of the population in Victoria is either in National Parks reserves, the John Smith Memorial Sanctuary or Crown Land. In South Australia the small population showed signs of sheep grazing in the area so it has been considered vulnerable as defined by Leigh, Briggs and Hartley (1981).

D.J.E.Whibley
State Herbarium of South Australia
Adelaide 5000

Del. J. Morley
Gumeracha, South Australia 5233

Cheiranthera volubilis Benth, A, several branches each ending in a flower, x 0.7; B, insertions of leaves on branch, x 1; C, flower bud and developing fruit, x 0.7; D, transverse section through leaf, x 4; E, flower in close up, x 3; F, flower with sepals and petals removed in side view, x 3.

Acacia glandulicarpa Reader. A, habit, x 0.7; B, phyllode in back view, x 2; C, phyllode in front view, x 2; D, flower, x 10; E, legume, x 0.7; F, portion of legume, x 2; G, portion of legume opened to show seeds on funicle, x 2; H, glandular hair from legume, x 6.

Swainsona tephrotricha F. Muell. A, habit, x 0.7; B, standard in front view, x 1; C, standard in back view, x 1; D, wing from the inside, x 1; E, keel in side view, x 1; F, flower with petals removed, x 1; G, flower in side view, x 1; H, legume from above, x 1; J, legume in side view, x 1; K, opened legume, x 1.

Pseudanthus micranthus Benth. A, habit, x 1; B, branchlet with flower buds, x 3; C, mature stem with two female flowers and one male, x 3; D, female flower, x 6; E, developing fruit, x 3; F, aborted fruit from previous year, x 3; G, male flower on mature stem, x 5; H, male flower in side view, x 10; G, male flower in surface view, x 10.

15. **Swainsona tephrotricha** F. Muell. (Leguminosae-Papilionoideae)

Swainsona tephrotricha F. Muell., Linnaea 25 (1853) 392.

Illustration: A-G Based on fresh flowering material preserved under *R. Davies & W. Bushman 518*, 29.vii.1983, 2.5 km WSW Eudunda along main road to Kapunda (AD); H-K from: *R.H. Kuchel 3113*, 14.ix.1973, Arkaroola, Flinders Ranges (AD).

Ascending or suberect perennial, with pithy stems, usually 10-30, sometimes 100 cm high; indumentum of dense silvery or grey medifixed, flattened hairs, appressed, sometimes with the ends spreading on stems, leaves and peduncles. *Leaves* 3-10, commonly c. 5 cm long, with (9-) 13-17 (-19) leaflets; leaflets oblanceolate to elliptic, 7-30 x 2-15 mm, broadly acute, with recurved mucro, pubescent evenly on both sides; stipules lanceolate, 5-8 mm long, pubescent. *Flowers* few to 30 on the distal half of the peduncle 8-30 cm long, flowers 8-10 mm long, pedicels c. 2 mm long, densely pubescent with dark and/or white hairs; bract ovate-lanceolate, slightly longer or shorter than hoary pedicel; bracteoles subulate, to 0.5 mm long, inconspicuous. *Calyx* 4-6 mm long, densely covered with grey and/or dark hairs giving it a dark appearance; teeth triangular, c. 1 mm long. *Petals* brilliantly rose-pink, drying purplish; standard broadly obcordiform, about as long as broad, with oblique venation, without calli, with a wide short claw c. 2 mm long; wings shortest, oblong on a slender claw c. 3 mm long; keel shorter than the standard, semicircular, obtuse, often with a pair of folds near the auricle, with slender claw c. 3 mm long. *Ovary* shortly stipitate, fusiform, appressed-pubescent with short hairs except for longer and spreading ones along the suture; style slender, bearded along whole length, with tip slightly but never abruptly bent, a minute tuft of obscure hairs behind the stigma. *Pod* subglobose, c. 10 mm long, slightly impressed along suture, distinctly beaked, densely pubescent with white hairs, 10-20-seeded. *Seeds* reniform, up to 2 mm long, brown.

Swainsona tephrotricha is usually found on higher ground and slopes in brown earth with limestone and/or shale in a variety of plant associations ranging from open semi-arid tussock grasslands to open shrublands and disturbed roadside vegetation invaded by exotics.

The most northern part of the distribution of the species is confined to a region around Arkaroola in the Gammon Range of the northern Flinders Ranges and there are several records known of it. Only one or two have been collected to the south at Wilkawillina Gorge and Pekina; a single collection from Terowie in the Northern Lofty Region is preserved in the Adelaide Herbarium. From the Murray Region only one collection from Panaramitee Dam, south of Yunta and Eudunda is known.

The collection *R. Davies & W. Bushman 518* from just south of Eudunda has notes on the ecology of the plants. They found 57 healthy plants with new growth on a gentle west-facing slope together with *Stipa* sp.. *Avena* sp., *Maireana brevifolia* (R. Br.) P.G. Wilson, *Salsola kali* L., *Marrubium vulgare* L., *Echium plantagineum* L., *Lomandra effusa* (Lindley) Ewart and *Vittadinia blackii* N. Burb.

Here the survival of the plants could be threatened due to indiscriminate collecting because these are readily accessible populations of such showy flowers. Although the species seems to occur over such a large area between Eudunda and Arkaroola it is found only in a few scattered localities where it might be locally abundant. The plants are threatened with extinction throughout its distribution range due to heavy grazing by sheep and especially goats.

Swainsona tephrotricha was described by F. Mueller from Burra and the rivers Broughton, Hut and Hill. Subsequently Bentham (1864) reduced it to varietal level as *S. lessertiifolia* DC. var. *tephrotricha*. A.T. Lee (1948) reinstated it to species level in her revision of the genus and chose Mueller's specimen from Burra as the lectotype relying on observations published by Black (1927).

References

Bentham, G. (1864). 'Flora Australiensis'. (Reeve: London).
Black, J.M. (1927). Additions to the flora of South Australia No. 25. *Trans. Roy. Soc. S. Aust.* 51: 381.
Lee, A.T. (1948). The genus *Swainsona. Contr. N.S.W. Natn. Herb.* 1, 4: 188-9.

J.Z. Weber
State Herbarium of South Australia
Adelaide 5000

Del. J. Morley
Gumeracha
South Australia 5233

16. **Pseudanthus micranthus** Benth. (Euphorbiaceae)

Pseudanthus micranthus Benth., Fl. Aust. 6: 59 (1873).

Illustration: Based on fresh flowering material preserved under *R. Davies & W. Bushman 553*, 18.vii.1983, below Toc. H. camp, Victor Harbor (AD).

Dwarf shrublet, rigid when with intricate branching, otherwise slender, 10-20 cm high, with some branchlets extended to 30 cm long, minutely pubescent with short, stiff, thick, greyish or often reddish hairs; woody branches arising from a tap root. *Leaves* alternate, rarely opposite, on distinct glabrous petiole to 0.5 mm long, evenly and widely spaced on greyish or reddish branchlets; lamina obovate or oblanceolate, 2-6 mm long, 1-2.5 mm wide, acute, glabrous and glaucous above, minutely papillose beneath, the midrib visible on the lower face often ending in a small mucro; stipules filiform, c. 0.5 mm long, brown, often caducous. *Flowers* unisexual on monoecious plants. *Male flowers* 1-3 in axil of leaves on terminal leafy shoots, turbinate, 1-1.5 mm long, attenuate into a pedicel to 1/3 of its length. *Tepals* 6, subequal, ovate, to 1 mm long, yellow with reddish tinge dorsally, imbricate in bud, rotate. *Stamens* 3, nearly as long as the perianth, with filaments free at the base, alternating with lobes of a minute rudimentary ovary, joined near the apex (probably by interlocking papillae) where the anthers form a crown; anther cells semiglobular, c. 1 mm across, usually red, dehiscing longitudinally, deciduous after anthesis. *Female flowers* solitary, sessile, scattered among male flowers. *Tepals* 5, 3 outer ones lanceolate-costate, 1.5-2 mm long, yellow usually tinged red distally, the inner segments ovate and shorter than outer ones, yellow-hyaline. *Ovary* if 2-locular then laterally compressed, if 3-locular then 3-lobed, each locule with 2 ovules and tapering into a recurved style to 0.5 mm long, undivided, dorsally papillose, rarely capitate. *Capsule* obliquely ovoid, 4-5 x c. 3 mm, with three ridges dorsally, 1-locular and 1-seeded by abortion, light greenish-yellow turning brown, faintly reticulate. *Seeds* subglobular to ovoid, 2.5-3.5 x 2.5-3 mm, brown, smooth, shiny, slightly apiculate, without any fleshy terminal outgrowth (caruncle).

The species is rather restricted in the Southern Lofty Region from Port Elliot, Victor Harbor and Waitpinga through the Inman Valley, Willow Creek to Mount Compass, Yankalilla and Normanville. Flowers are apparently found throughout the year.

The unusual locality of the following specimen raises doubts as to its correctness as all other specimens of this species are from the restricted distribution on the southern Fleurieu Peninsula. Professor R. Tate sent material, according to the label, to F. Mueller in Melbourne who based on it the new species *Phyllanthus tatei*. Unfortunately the original note from Tate was not preserved and the specimen is labelled as being collected from the Bundaleer Range in the Northern Lofty Region. Later J. Black seemed to have examined this specimen and/or was given part of this collection for his own herbarium and copied in his own hand Mueller's locality onto the label. Black (1924) made the new combination *Micranthus tatei* (F. Muell.) J. Black but reversed his decision again in 1948. Eichler (1965) then placed the species into the synonymy of *Pseudanthus micranthus* where it is still maintained.

These rigid plants are apparently not grazed by sheep or cattle. They are found on hill sides, roadsides and sandy places where the long tap root penetrates the soil. When the plants are growing between shrubs or bushes and sheltered between them, the habit of the plant is more slender and branches are more straight and erect.

References

Black, J.M. (1924). 'Flora of South Australia' 356. (Govt Printer: Adelaide).
Black, J.M. (1948). 'Flora of South Australia, 2 edn, 511. (Govt Printer: Adelaide).
Eichler, H. (1965). 'Supplement to J.M. Black's Flora of South Australia' 210. (Govt Printer: Adelaide).
Mueller, F.J.H. (1882). Definitions of some new Australian plants. *Southern Species Record* (March 1882) 55.

J.Z. Weber
State Herbarium of South Australia
Adelaide 5000

Del. J. Morley
Gumeracha
South Australia 5233

CORRIGENDA

J. Adelaide Bot. Gard. 5 (1982)

Page 3, line 41: delete 'MEL'

Page 45, to the legend of Fig. 18 add

'Scale 2 cm.'

Page 69, line 21: insert after 'possibly' the word 'promoted'.

Page 91, line 13; page 94, line 36: replace 'Curtis' with 'Airy Shaw'.

Page 116, line 34; page 119, line 10; page 120, line 21; page 122, line 38; page 126, line 2; page 128, line 36; page 131, line 43; page 139, line 35; page 199, line 32: replace 'Curtis in Stones & Curtis' with

'Airy Shaw in Stones & Curtis'

Page 159, lines 30, 31: replace 'ssp. *collina*' with

'subspecies'

Page 204, Fig. 71: the omitted centimetre scale line is 1.15 cm long.

Page 264, line 6: replace 'a few tiny mm long)' with

'a few tiny glandular hairs (less than 0.05 mm long)'

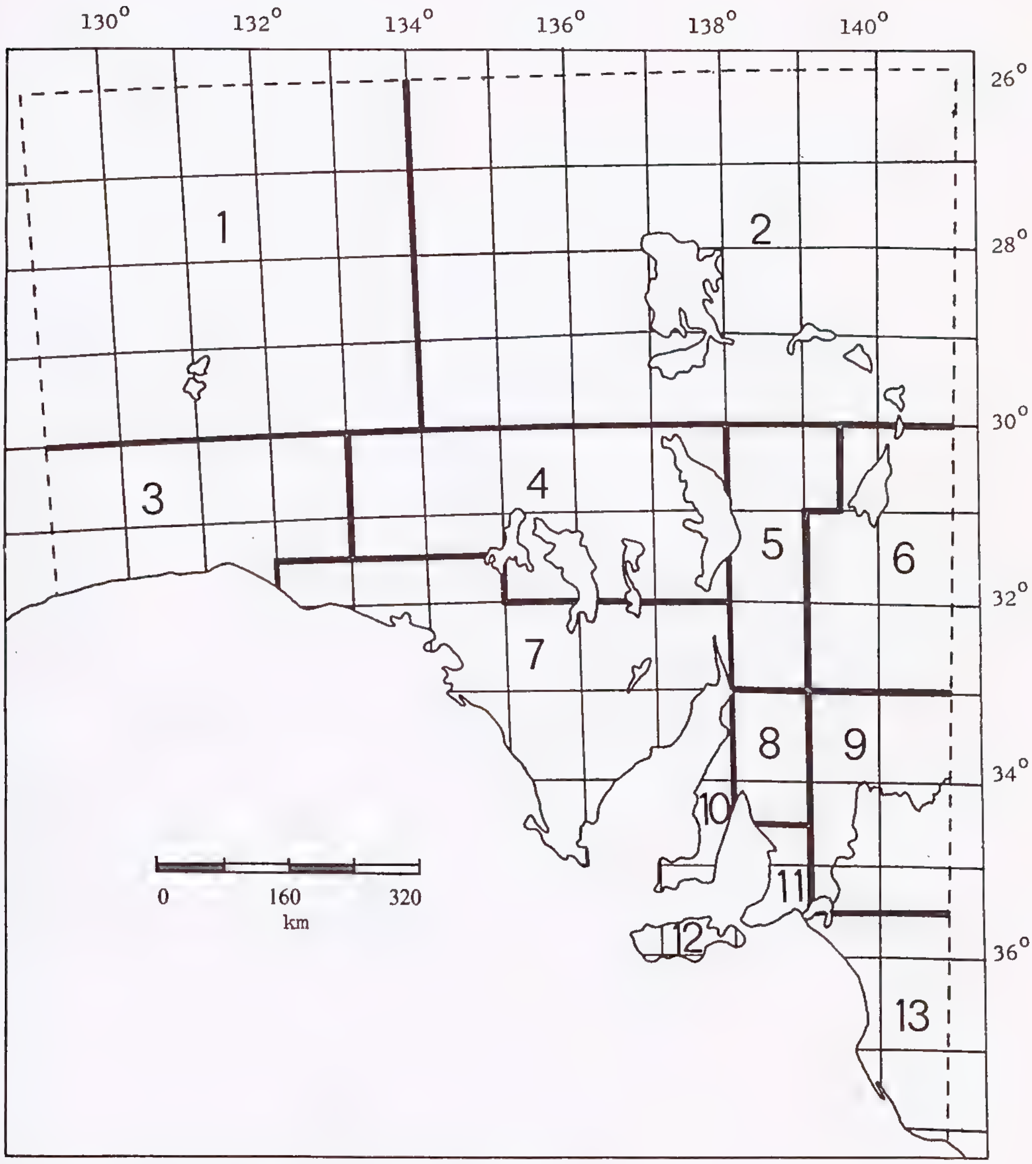
J. Adelaide Bot. Gard. 7(1) (1984)

Page 135, line 3 from bottom: replace 'shortly ciliate on their distal margin' with

'without terminal bristles. *Monopsis*'

REGIONS OF SOUTH AUSTRALIA ADOPTED BY THE STATE HERBARIUM — ADELAIDE

1. North-western
2. Lake Eyre Basin
3. Nullarbor
4. Gairdner-Torrens Basin
5. Flinders Ranges
6. Eastern
7. Eyre Peninsula
8. Northern Lofty
9. Murray
10. Yorke Peninsula
11. Southern Lofty
12. Kangaroo Island
13. South-eastern



Typeset by P. & L. REPRODUCTIONS PTY. LTD.
Printed by AUSTRALIAN PRINTING SPECIALISTS

JOURNAL of the ADELAIDE BOTANIC GARDENS

CONTENTS

JOURNAL of the ADELAIDE BOTANIC GARDENS

Volume 7 Part 3

15 July, 1985

Instructions to Authors

Topics

Papers will be accepted in the following categories:

(a) Plant systematics (Australian and horticultural groups); (b) Descriptive plant morphology, anatomy and ecology; (c) Obituaries, biography and history; (d) Bibliographic studies, book reviews; (e) Botanical illustrations; (f) Noteworthy horticultural contributions. Preference will be given to unpublished material of suitable standard not intended for publication elsewhere.

Copy

Manuscripts must be typed, with double spacing and margins at least 3 cm wide, on one side of the paper only. Three copies must be submitted. Captions must not be italicized, underlined or typed in capitals. All scientific names of generic or lower rank must be underlined.

The print area for illustrations is 18 x 13 cm (excluding captions). Half-tone material should be submitted this size if possible, but will be reduced by the printers, if necessary.

Reprints

50 copies of reprints will be provided for each paper. Additional reprints may be purchased at cost.

Layout

The pattern of the paper should generally be:

(i) Title; (ii) Author and Address; (iii) Abstract (except for short papers); (iv) Introduction and subject matter; (v) Acknowledgements; (vii) References.

References

Text references to publications should be indicated as follows: (Smith, 1959), (Smith, 1959, p. 127), Smith (1959) or Smith (1959, pp. 125-208). The final section of the paper, headed 'References', should include only those titles referred to in this way. It should be laid out as follows:

Smith, L. L. (1879). The species of *Danthonia* found in pastures in Victoria. *Austral. J. Bot.* 65: 28-53.

Bentham, G. (1868). "Flora Australiensis", Vol. 4. (L. Reeve: London).

Baker, J.G. (1898). Liliaceae. In Thiselton-Dyer, W. T. (ed.). "Flora of Tropical Africa", Vol. 7. (L. Reeve: Ashford).

Journal abbreviations must be consistent within a paper and authors are recommended to follow "Botanico-Periodicum-Huntianum". Journals not cited in B-P-H should be abbreviated to conform with this general pattern. The following abbreviations for Australian states should be used: WA, NT, SA, Qld, NSW, ACT, Vic., Tas.

Text references to specimens should be italicized, for example *Kock 276.*

Indices

When required, follow the pattern on, for example, p. 106 of vol. 1, pt. 2.

Recommendations on taxonomic papers

Synonymy

Authors are requested to include in the synonymy only references to publications containing information additional to that to be published in the paper being submitted. Within this section journal and book titles must be conistently abbreviated. B-P-H journal abbreviations and book titles abbreviated in a similar way are desirable. Authors of references cited in the synonymy should preferably be abbreviated according to the 'Index of Author Abbreviations' compiled and published by Royal Botanic Gardens, Kew (1980). References may be cited as:

Benth., *Fl. Austral.* 4: 111 (1868) OR

Benth., *Fl. Austral.* 4: (1868) 111.

Citation of specimens

10-30 specimens should be cited for each species (or subspecific taxon), although this may be varied under certain circumstances. The author may decide whether or not to include dates of collections and the sequence, provided a constant pattern is adhered to throughout a paper.

Authors wishing to cite all specimens seen may list them all in an index to collectors after the style of the "Flora Malesiana" identification lists. Collections not identifiable by a collection number (assigned by either the collector or herbarium) should cite dates.

Correspondence

All correspondence concerning the journal should be addressed to:

The Director, Adelaide Botanic Gardens, North Terrace, ADELAIDE, South Australia 5000.

ISSN 0313-4083

J. Adelaide Bot. Gard. 7(3): 217-231 (1985)

PLANT INTRODUCTIONS TO SOUTH AUSTRALIA PRIOR TO 1840

P.M. Kloot

South Australian Department of Agriculture, G.P.O. Box 1671, Adelaide, S.A. 5001

Abstract

Selected historical data from 1802 to 1840 are presented to illustrate the extent of European plant introductions in both pre-colonial South Australia and the early years of official settlement. Some other effects such as land clearing and the early movement of weeds are briefly discussed.

Introduction

South Australia was proclaimed a colony of the British Crown on 28 December 1836 when the first Governor, Captain John Hindmarsh RN, hoisted the British flag at a ceremony on the shores of Gulf St Vincent. Prior to this date there had been a flurry of activity which had commenced on 27 July the same year when the advance party of settlers and surveyors had arrived on the "Duke of York" to lay the foundations for a Province of free settlers to be developed in accordance with the novel Wakefield Colonization Plan (Price, 1924). Apart from recounting the story of the earliest navigators, Flinders and Baudin, many historians make no mention of European involvement in South Australia prior to 1836 (e.g. Dutton, 1846; Sinnett, 1862; Pascoe, 1901). Passing references are sometimes made to the earlier presence of sealers and others on the off-shore islands but as they are not considered to have any direct bearing on the official settlement of the colony, they are dismissed as being of little importance in South Australian history. This underestimates their role in the wider history of South Australia and ignores the significant modification of the environment of the coast and off-shore islands that they caused over a long period.

Furthermore the first years of official settlement saw a remarkable expansion in agriculture and horticulture in South Australia. I believe that this was a result of the Wakefield Colonization Plan which has not been considered before.

In this paper I will present selected historical data from 1802 to 1840 to illustrate the extent of plant introductions by Europeans and some of their effects on the local vegetation. This span includes a period of 34 years prior to official settlement and the following four years during which agriculture became established.

Modification of the environment

The arrival of Europeans had two basic effects relevant to this topic—habitat disturbance and plant introduction. The former is caused by a) the establishment of camps, huts and in time, settlements with their attendant soil disturbance and rubbish dumps, etc., b) the grazing of ruminants and the deposition of large dung patches for neither of which are the native herbs and grasses adapted, and c) farming, which includes the removal of native vegetation, the cultivation of the soil and the subsequent planting of crops and pastures. Plant introduction may be intentional such as the sowing of crops, pastures, fruit and vegetables or it may be unintentional as with the dispersal of weeds which, in this context are plants adapted to co-exist with the activities of Man. Introduced plants generally require some modification of the environment for their successful establishment. The unsubtle invasion of Europeans into the fragile environment of South Australia was more than sufficient disturbance for the successful establishment of 100 alien plants by 1850 (Mueller, 1853; Kloot, 1983).

Whilst the extent of such effects was limited generally to the coast and off-shore islands in pre-colonial South Australia, I suggest that they were as important where they occurred as were the changes wrought by the 'official' settlers after 1836, who ranged much further inland and who by 1840 had greatly influenced the local vegetation.

The first contacts

European involvement with South Australia appears to have commenced in 1802. This is much later than other parts of the Australian coast. From the west, the Dutch had explored by 1627 the southern Australian coast as far as the Isles of St Francis (Fig. 1), but they and later explorers approaching from the west found the coastline so inhospitable as to discourage closer examination or to invite further eastward exploration. The generally accepted first European contact from the east was by the British in 1770 but that only involved the eastern Australian coast. McIntyre (1977) produced convincing evidence that the Portuguese anticipated Captain Cook by about 250 years but even so, the farthest west he claimed the Portuguese to have explored was the coastline near Warrnambool in Victoria.

Whilst some other casual contact cannot be completely excluded it would appear that what is the coastline of present-day South Australia was explored by Europeans much later than the rest of the Australian coast. Furthermore whilst the indigenous peoples of various Indonesian islands, New Guinea and other islands to the north had visited Australia intermittently for millenia (Dortch and Muir, 1980), because of the distances involved this contact did not affect southern Australia. Even if it had, any plants introduced intentionally or accidentally from these tropical origins would have been unlikely to succeed in the completely different environment of southern Australia.

By chance the first two recorded European contacts coincided when a British ship "The Investigator" under Matthew Flinders sailed in South Australian waters on its circumnavigation of the Australian continent between January and April 1802. A French expedition commanded by Baudin sailing westward reached there in March and remained until late April. In spite of their countries being at war they met cordially in the bay near the entrance to the Murray River later named by Flinders as Encounter Bay. To botanists, these expeditions are extremely valuable. Robert Brown patronized by Sir Joseph Banks was on Flinders' ship and Jean Leschenault and Andre Michaud were on the French ships.

Both the British and French expeditions landed on Kangaroo Island (Figure 1) at various places to camp, to explore and to collect specimens. These expeditions were themselves agents of introduction. Baudin (1974) noted in his journal that on his second visit in January 1803 he left a rooster and some hens, a boar and a sow "for the benefit of future navigators". The wild pig hunting of later years is evidence that the pigs thrived but there is no further mention of the fowls (Cooper, 1954).

Even more pertinently, Peter Good the gardener on Flinders' voyage, listed a number of seeds that were sown in the vicinity of the Spring, near present-day Penneshaw, and various other situations on Kangaroo Island on 2, 4 and 5 April 1802, also as an aid to future sojourners (Edwards, 1981). They were: orange, lemon, cherry, rock melon and cantaloupe, cucumber, gourd, onion, leek, turnip, beet, radish, cress, mustard, lettuce, cabbage, savoy, spinach and sea kale. The three fruit trees were probably seedlings in which case the soil around their roots would have contained weed propagules. It is highly likely that the vegetable seed would have contained impurities and that weeds were thus introduced. Perhaps the weeds were more successful than the intended plantings, but I have not been able to locate any further reference to Good's plants or any weeds.

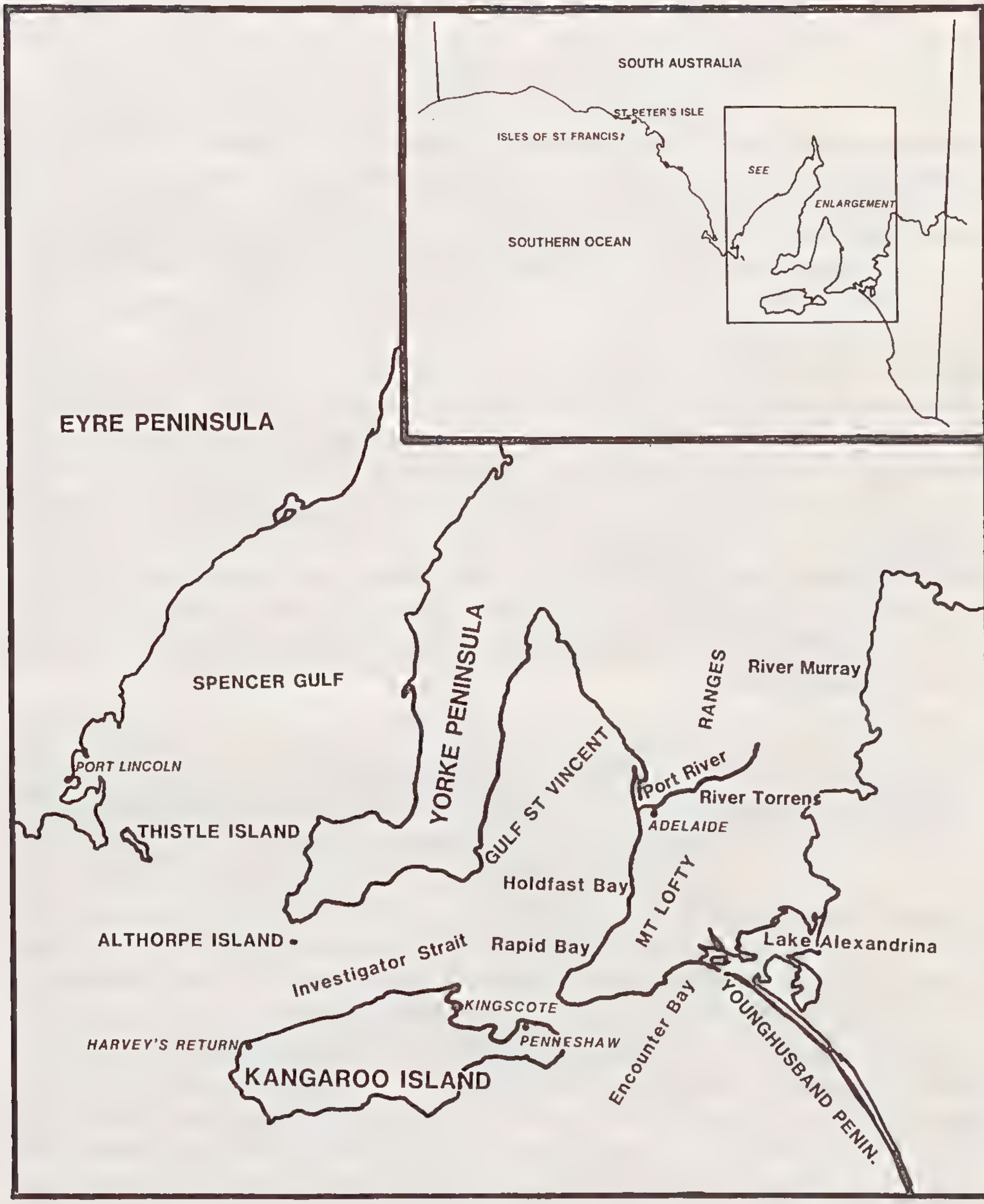


Fig. 1. South Australia, showing localities mentioned in the text.

The earliest settlements

Kangaroo Island

Soon afterwards Kangaroo Island became the focus of European involvement with South Australia. As a large uninhabited island it was an attractive base for parties of sealers who were left there for various terms to amass skins for traders based in Sydney, Hobart and elsewhere (Cumpston, 1974). The rough life of Kangaroo Island gave rise to accounts of runaway convicts and outlaws (e.g. Sutherland, 1834), which Cumpston (1974) considered to be highly exaggerated but which were given credence by earlier historians who ignored the pre-colonial settlers of Kangaroo Island in their attempts to stress the higher social origins of South Australia (e.g. Pascoe, 1901) compared to the other Australian states.

The first recorded European contacts as noted above were in 1802, but there was evidence of some unidentified European contact in 1800 (Leigh, 1839) and according to Flinders' diary (cited by Wace, in press) he was expecting to meet European sealers in the vicinity of Kangaroo Island. From 1803 onwards there was intermittent settlement. From 1806 European settlement was continuous, and involved large numbers of people. In 1825, at the peak of the sealing industry, there were two hundred souls present on Kangaroo Island. Cumpston (1974) has identified at least 500 individuals who dwelt on Kangaroo Island for different periods prior to the arrival of the official colonists in 1836. To supply their needs cereal and vegetable crops were sown and domestic animals introduced. Although I cannot locate any specific reference it is reasonable to assume that medicinal plants would have been introduced also. According to Sutherland (1834) the cabbages that he planted in 1819 were the first on the Island, the sealers previously using an unnamed native plant in the same manner as cabbage, which would suggest that the cabbages, at least, planted by Good in 1802 had failed to become established. In 1831 there were a number of small gardens growing vegetables, potatoes and onions and barley for the poultry (Cumpston, 1974). By 1836, when the official Colonists arrived on Kangaroo Island they found wheat, turnips, cabbages, onions, potatoes, barley and water melons. One settler, Wallen, had four acres under wheat and a "large kitchen garden filled with every description of vegetable as in England" (Cumpston, 1974).

The first explorers to reach Kangaroo Island in 1802 spoke of grass plains (Baudin, 1974: Flinders, 1814). Even in 1819 Captain Sutherland trekked across the island without any apparent hardship noting extensive grasslands in his account (Sutherland, 1834). On the basis of his experience a group of six of the first official colonists left their ship, the "Africaine", at Harvey's Return as a relief from the long sea voyage from England to follow Sutherland's path overland and to rejoin the ship at Kingscote. Two of the party perished and the others barely survived because they were blocked by thick impenetrable scrub. In view of Sutherland's general assessment of Kangaroo Island, which was found to be over-optimistic, the feeling was that he had fabricated the whole report (Stephens, 1839; Cumpston, 1974) but I suggest that he did not. As a result of hunting for food and sport, between 1802 and 1836 the kangaroo population was almost exterminated, a visitor in 1837 noting that "there is not a kangaroo within twenty or thirty miles of a settlement and no emu had been seen for ten years" (Leigh, 1839). Combined with the ravages of frequent fires, this may have been the cause of the impenetrable regrowth of mallee and heath-type vegetation which claimed the lives of the early colonists. Observations by this writer of exclosures at the Cleland Wildlife Park near Adelaide revealed that the effect of kangaroos grazing on the regrowth of native vegetation is severe, for where they have been excluded for even two years, the vegetation is a mass of tangled regrowth. In a recent paper on the taxonomy of the Kangaroo Island kangaroo, Poole (1976) entirely overlooked the effects of the pre-colonial settlers. He concluded that the scarcity of the kangaroos during the nineteenth century was only apparent, and occurred because there were very few observers who saw them because of the slow rate of land clearing. I suggest that the populations were depleted to such

an extent that the only surviving populations were confined to the uncleared distant parts of the Island, particularly the western end. In fact, in 1874 the Australian Directory (quoted by Cumpston, 1974) stated that the kangaroo was already extinct and the wallabies would soon be so.

Other islands

Other suitable islands were also inhabited from time to time by sealers (Cumpston, 1974). Althorpe Island in Investigator Strait and Thistle Island in Spencer Gulf were both settled from 1815. Thistle Island was farmed by an escaped convict and his two aboriginal wives for some years. By 1831, they had established "a good garden, small wheat and barley paddocks, with pigs, goats and poultry". They were self-sufficient in everything except for tea and tobacco. There are less definite references to sealers living on Nuyts Archipelago (Moore, 1925) and St Peter's Island (Cumpston, 1974) but as the latter together with the Isles of St Francis are part of the Nuyts Archipelago, the two references may be to the same settlement.

The Adelaide area

From Kangaroo Island marauding parties visited the mainland seeking aboriginal women as well as seals. The cruelty of the islanders to the aboriginals of the mainland resulted in violent reprisals wherever possible. One of the most well-known was the killing of Captain Barker by aboriginals on Younghusband Peninsula in 1831. It is clear that the Kangaroo Islanders had explored parts of the mainland close to Kangaroo Island for they gave much guidance as to the topography of the mainland to the explorer Sturt and afterwards to the first official colonists. Shortlived settlements were established by the River Torrens. Captain Barker, previously mentioned, explored parts of the Mt Lofty Ranges and travelled overland from Rapid Bay to the mouth of the Murray River in 1831. Sturt travelled down the Murray to Lake Alexandrina and returned upstream in 1831 but sealers had discovered the lake at least 18 months earlier (Moore, 1925; Cumpston, 1974). A Captain Jones discovered the Port River and landed at a number of places on the coast near Adelaide in 1834 (Jones, 1933).

The peninsulas

Sturt (1833) quotes the opinions of sealers as to the merits of Eyre and Yorke Peninsulas which implies that they were familiar with these areas. The area around Port Lincoln had been explored by 1810 and from 1829 to 1832 there was a settlement there of 30 people (Moore, 1925). Sutherland (1834) mentioned that he had visited Yorke Peninsula in 1819.

Botanical implications

This European activity is South Australia included the three elements of habitat disturbance—settlement, grazing and farming. The degree of disturbance differed considerably from place to place. Presumably the passage of Sturt's party by boat along the Murray would have had a negligible effect on the environment, but in contrast there were areas on Kangaroo Island and elsewhere that were intensively farmed. Plants would have been introduced both intentionally and accidentally. Crop seeds would surely have contained contaminants for we may assume that the seed imported from Tasmania or elsewhere in pre-colonial times was as adulterated as that imported later. Stock would have brought propagules on their fleece and coats, and implements brought from elsewhere were likely to have carried propagules. Water barrels could have picked up and dropped fragments of aquatic weeds as they were filled in various waterbodies. Clothing and footwear could also contain plant propagules and Charles Dickens in *David Copperfield* graphically describes "ploughmen bodily carrying out soil of England on their boots" on board an emigrant ship about to sail for Australia.

Unfortunately, there is no mention of weeds of that period. But we can be certain that they were present. It is instructive to consider available lists of alien plants recorded early in the history of the other parts of Australasia.

About 15 years after the establishment of Sydney, Robert Brown compiled a list of introduced plants which were growing, mostly spontaneously, in the area in the years 1802 to 1804 (Britten, 1906). Another catalogue is available from Victoria (Hannaford, 1856) and although it is from a slightly later period, it is still a useful comparison of early introductions. A further list was prepared of plants naturalised in New Zealand up to about 1845 from the works of Richard (1832), Cunningham (1836-1839) and Raoul (1846) taking into account the comments of Allan (1937). A final listing of aliens naturalised up to 1875, on Lord Howe Island which was settled about 1830 was drawn up from the extensive records of Pickard (1984). These four lists are presented in Tables 1-4.

Assuming that the weedy species noted by the various authors arrived at the respective locations in crop seeds, or stock, implements or clothing that had been brought from Europe, either directly or via other European settlements in South Africa, India or the Americas, then it is reasonable to assume that the same species could have reached South Australia by the same means. It is noteworthy that, excluding the four noted as doubtful, 19 of the 25 species from Sydney, 45 of the 68 species from Victoria and 16 of the 29 species from New Zealand appeared in the listing of 100 species that were naturalised very early in South Australia (Kloot, 1983). The species common to both Lord Howe Island and South Australia are somewhat fewer than for the other locations, as that island is the most dissimilar ecologically to South Australia. As indicated in the tables additional species were present in South Australia, although not naturalised. Furthermore, excluding the doubtful records, all the listed species except *Fragaria vesca* (probably *Duchesnea indica*), *Malva neglecta*, *Juncus polyanthemos* and *Morus alba* are currently naturalised on Kangaroo Island and/or the adjacent coastal areas of South Australia (Jessop, 1983).

South Australia was not visited by botanists of Brown's calibre until the mid-1840s (Kloot, 1983). By that time it was impossible to differentiate between species introduced before or after 1836. For Kangaroo Island itself, the first systematic collection of alien plants was not undertaken until about 80 years after the first European contact (Tate, 1883).

There is one intriguing observation that is suggestive of a pre-colonial introduction. James Backhouse, who was a tolerably good botanist, visited Adelaide in 1837 and specifically noted *Verbena officinalis* L. growing near the River Torrens (Backhouse, 1843). This plant was a widely used folk medicine which may have been deliberately planted by the early settlers to ensure a supply for their mainland camps. Alternatively, as this plant is dispersed by adhering to the coats of domestic animals and men's clothing (Ridley, 1930), it could have been brought accidentally from Britain where it is found on roadsides and in waste places (Salisbury, 1961). However, this issue is uncertain because *V. officinalis* has never been found on Kangaroo Island (Jessop, 1983).

The official colonists

Thirty-four years after the first European contact, the first official colonists arrived. They first disembarked on Kangaroo Island where, among other things they planted lettuces, radishes and cabbages which were flourishing when seen by Robert Gouger in November 1836 (Gouger, 1838). Following the decision not to proceed with settlement of Kangaroo Island, the settlers moved across to the mainland at Holdfast Bay. There they encamped, planted more gardens, which were continually devastated by the stock that had been disembarked and allowed to graze the grassy plains of what are now Adelaide seaside suburbs (Hope, 1968), and awaited the arrival of Governor Hindmarsh to proclaim the foundation of a colony of free settlers.

Because these pioneers and those who followed them came freely with the intention to settle and make a new life in South Australia, they brought with them all the goods and chattels that they considered would be necessary. From a botanist's point of view some of their paraphernalia are most interesting. There was an immediate importation of propagules of plants of agricultural, horticultural and sentimental value (Charlwood, 1981). As an example, Gouger, the settler mentioned earlier who arrived in 1836 on the "Africaine", noted in his diary (Hope, 1968) that in his cabin "a pot plant of heliotrope had died but he was keeping the stump, hoping it would reshoot". He also had a mignonette plant that had died after it had seeded, and he had gathered the seeds for planting when he arrived. At that time he also had a musk plant that was still alive. An unnamed settler advertised seed of wheat, oats, turnips etc. for sale in August 1838. He had brought them from England but was unable to use them (Anon., 1838). Presumably many settlers did likewise. During 1838 and 1839 many advertisements appeared in the Adelaide Press announcing sales or auctions of garden seeds, including oak, sycamore, ash, beech, clover, trefoil and vegetables (Clay, 1838), many fruit trees and shrubs such as Dutch and Chinese honeysuckles, barberries, Cape alleternis [*Rhamnus alaternus*], nerium splendens, jassamines [sic], laburnum, althea frutex, hibiscus laphantha, bignonia, Keria, moss, guilder and other roses (Anon., 1839) and clover and grass seeds, larch, spruce and Scotch firs, hawthorn, yew and holly berries, various fruit and flower seeds and many and rare bulbous roots (Anon., 1839a).

Apart from the introduction by private settlers, the Colonial Government was involved also. In spite of the pressing financial problems of the newly-founded settlement, funds were provided to purchase plants for a Government Garden which was established in 1837. Some of these purchases are recorded on files from the Colonial Secretary's Office at present in the S.A. State Archives. Thus CSO 1837/276a records a list of fruit trees bought from an unnamed source for the Garden. The list includes "Oranges, (illegible), dahlias, tiger lilies, rosetree, cherries, mulberry, quince, nectarine, Japanese loquats". A letter of 9 August 1837 refers to the purchase of peach and apricot trees, mulberry, Lisbon lemon and flowers. The emphasis of the gardens was more utilitarian than ornamental and the manager, Thomas Allen, was permitted to sell the vegetables he produced. Contemporary newspapers contain a number of advertisements for his produce.

Colonisation was followed by a rush to determine the potential of the new colony which was expressed by extremely fast exploration of what later became the settled areas and, more relevantly to our subject, by an incredibly intense testing of agricultural and horticultural species to examine the success or otherwise of their trans-oceanic relocation. For example, Stephens (1839) lists the following as being grown in an unnamed settler's garden in 1837:

> Radishes, mustard, cress, cabbages, peas, potatoes
> Lettuces, leeks, spinach, red cabbage, cauliflower, turnips, broadbeans, parsley, onions, love apples [i.e. tomatoes] etc.
> Indian corn [i.e. maize]
> Apple trees, cherries, almonds, gooseberries, currants, almonds, vegetable marrows, gourds, cucumbers, melons and water melons.
> Pink, blue and yellow lupins, hyacinths, narcissi, anemones, mignonette, chrysanthemums, sweet peas, laburnums, Virginian stocks, convolvulus, candy tuft, mallows and nasturtiums.

In a series of lectures delivered in late 1839, less than three years after the foundation of the colony, George Stevenson was able to give detailed instructions based on his own experience as to the husbandry of an incredibly wide range of fruits and vegetables (Stevenson, 1839). That some of his advice, for example the growing of bananas, was over-optimistic does not detract from the effort that went into these enquiries. Settlers were encouraged to bring plants. John Bailey, the Colonial Botanist, in a letter to the editor of the *S.A Register* published on 11 April 1840, *inter alia* appealed to future emigrants that

when their ships stopped at ports en route, they should endeavour to obtain plants and seeds. Even prior to this, Leigh (1839, p. 42) wrote of collecting seeds from a garden at the Cape of Good Hope en route to South Australia.

Apart from the intentional introduction of plants for horticultural purposes, weeds introduced before or after 1836 would also have moved around. The outward spread of weeds from the Adelaide area associated with stock movements was exacerbated for two reasons. Firstly all stock was landed at Holdfast Bay and secondly, because of delays in surveying and subdividing land the stock was run in common herds and flocks on the adjacent plains for over a year until landowners could take possession of their holdings and transfer their animals (Hope, 1968). It is not difficult to imagine that fodder and grain remaining from the long sea voyages from England or the much shorter ones from Tasmania would have been tossed out for the animals with the result that seeds would have become established, and moved outwards into the country. Also according to Capper (1838) "several varieties of rib grass [*Plantago* spp.], also chicory [*Cichorium intybus*], trefoil [probably *Trifolium repens*], burnet [*Poterium sanguisorba*] and other herbs" were growing. These were all pasture species used by English farmers, and it is highly likely that they were sown in a hopeless attempt to recreate English meadows in the driest state in the driest continent.

Conclusion

Reading South Australian history from a botanical point of view, one can sense the frenzied plant introduction, both intentional and accidental that went on in the first years of settlement. Furthermore, stock grazing and land clearing followed by cereal cropping were ecological traumas of the first order and the rapidity with which changes occurred must have been dramatic. Mueller (1853) writing fifteen years after the foundation of the colony probably had good reason to lament the disappearance of the native vegetation.

When the first botanists arrived in South Australia, and I think that this applies to Australia generally, they were overwhelmed by the richness and novelty of the strange flora. Consequently, they gave scant attention to the species that they knew from home. However, it is clear that the early botanists did not realise how fast plants could become naturalised, nor did they realise the extent of pre-colonial settlement or its impact on the flora.

Acknowledgements

I am grateful to Mr D.E. Symon and Dr N.M. Wace for their constructive criticism of the manuscript.

References

Allan, H.H. (1937). The origin and distribution of the naturalised plants of New Zealand. *Proc. Linn. Soc. Lond. Sess.* 150: 25-46.

Anon. (1838). Advertisement. *S.A. Gazette & Colonial Register,* 4 Aug. 1838, p 2.

Anon. (1839). Advertisement. *S.A. Register,* 16 Aug. 1839, p 2.

Anon. (1839a). Advertisement. *S.A. Register,* 7 Sept. 1839, Supplement.

Aston, H.I. (1973). "Aquatic Plants of Australia" (Melbourne: MUP).

Backhouse, J. (1843). "A Narrative of a Visit to the Australian Colonies" (London: Hamilton)

Baudin, N. (1974). "The Journal of Post-Captain Nicolas Baudin", transl. by C. Cornell. (Adelaide: Public Library).

Beadle, N.C.W., Evans O.D. and Carolin, R.C. (1972). "Flora of the Sydney Region." (Sydney: Reed.)

Bentham, G. (1867). Flora Australiensis, vol. 3. (Ashford: Reeve).

Britten, J. (1906). Introduced plants at Sydney, 1802-4. *J. Bot.* 44: 234-235

Capper, H. (1838). "South Australia". 2nd Ed. (Cheapside: Tyas).

Charlwood, D. (1981). "The Long Farewell". (Ringwood: Allen Lane).

Clay, J.F. (1838). Advertisement. *S.A. Gazette & Colonial Register,* 8 Sept. 1838, p. 1.

Cooper, H.M. (1954). Kangaroo Island's wild pigs. *S. Austral. Natural.* 28: 57-61.

Cumpston, J.S. (1974). "Kangaroo Island 1800-1836". 2nd Ed. (Canberra: Roebuck Society).

Cunningham, A. (1836-1839). Florae insularum Novae Zelandiae precursor.*Comp. Bot. Magazine* 2 & *Ann. Nat. Hist.* I Ser. 1-4.

Dortch, C.E. and Muir, B.E (1980). Long range sightings of bushfires as a possible incentive for pleistocene voyages to greater Australia. *W. Austral. Natural.* 14: 194-198.

Dutton, F. (1846). "South Australia and its Mines". (London: Boone).

Edwards, P.I. (ed) (1981). The Journal of Peter Good. *Bull. Brit. Mus. (Nat. Hist.) Hist. Ser.* 9.

Flinders, M. (1814). "A Voyage to Terra Australis". 2 vols. (London: Nicol).

Gouger, R. (1838). "South Australia in 1837". (London: Harvey and Darton).

Hannaford, S. (1856). "Jottings in Australia or Notes on the Flora and Fauna of Victoria". (Melbourne: Blundell).

Hope, P. (1968). "The Voyage of the Africaine". (South Yarra: H.E.A.).

Jessop, J.P. (1983). "A List of the Vascular Plants of South Australia". (Adelaide: Botanic Gardens).

Jones, J. (1923). Port Adelaide River—its first reported discovery. *Proc. Roy. Geograph. Soc. Austral. S.A. Branch.* 22: 73-75.

Kloot, P.M. (1983). Early records of alien plants naturalised in South Australia. *J. Adelaide Bot. Gard.* 6: 93-131.

Leigh, W.H. (1839). "Voyages and Travels with Adventures in South Australia". (London: Smith, Elder & Co.).

McIntyre, K.G. (1977). "The Secret Discovery of Australia" (Medindie: Souvenier Press).

Moore, H.P. (1925). Notes on the early settlers of South Australia prior to 1835. *Roy. Geograph. Soc. Austral., S.A. Branch Proc.* 25: 81-155.

Mueller, F. (1853). The Flora of South Australia. *Hooker's J. Bot. Kew Gard. Misc.* 5: 67-72.

Pascoe, J.J. (1901). "History of Adelaide and Vicinity" (Adelaide: Hussey and Gillingham).

Pickard, J. (1984). Exotic plants on Lord Howe Island: distribution in space and time, 1853- 1981. *J. Biogeog.* 11: 181-208.

Poole, W.E. (1976). Breeding biology and current status of the grey kangaroo. *Aust. J. Zool.* 24: 169-187.

Price, A.G. (1924). "Foundation and Settlement of South Australia". (Adelaide: Preece).

Raoul, M.E. (1846). "Choix de Plantes de Nouvelle Zelande". (Paris: Fortin, Masson & Cie).

Richard, M.A. (1832). Essai d'une flore de la Nouvelle Zelande, in A. Lesson and A. Richard "Voyage de Decourvertes L'Astrolabe—Botanique" (Paris: DuPuy).

Ridley, H.N. (1930). "The Dispersal of Plants throughout the World." (Ashford: Reeve).

Salisbury, E.J. (1961). "Weeds and Aliens". (London: Collins).

Sinnett, F. (1862). "An Account of the Colony of South Australia". (Adelaide: Government Printer).

Stephens, J. (1839). "The Land of Promise." (London: Smith, Elder & Co.)

Stevenson, G. (1839). Gardening in South Australia in "Royal South Australian Almanack and General Directory for 1840" pp. 21-56 (Adelaide: Thomas).

Sturt, C. (1833). "Two Expeditions into the Interior of Southern Australia". 2 vols. (London: Smith, Elder & Co.).

Sutherland, G. (1834). Report of a voyage from Sydney to Kangaroo Island in "Outline of the Plan of a Proposed Colony to be founded on the South Coast of Australia". (London: Ridgway & Sons).

Tate, R. (1883). The botany of Kangaroo Island. *Trans. & Proc. Royal Soc. S. Aust.* 6: 116-171.

Wace, N.M. (in press). Discovery, exploitation, settlement and scientific investigation of the St Francis Islands, Nuyts Archipelago.

Webb, C.J. (1978). Checklist of dicotyledons naturalised in New Zealand 1. Umbelliferae. *N.Z. J. Bot.* 16: 387-390.

Table 1—Introduced plants at Sydney, N.S.W., 1802-4, listed by Robert Brown (after Britten, 1906).
x = naturalised in South Australia before 1855 (Kloot, 1983);
o = present in South Australia by 1850—see text and unpublished data of the author.

Species as listed by Brown	Current name if different	Recorded early in S. Aust.	Comments
MONOCOTYLEDONS			
Poaceae			
Briza virens	*B. minor*	x	
Lolium perenne		x	
L. temulentum		x	
Panicum dactylon	*Cynodon dactylon*	x	
Phalaris canariense	?*P. minor*	x,o	*P. minor* was an early S.A. naturalisation (Kloot, 1983) and *P. canariense* an early introduction which has never become naturalised.
Poa annua		x	
DICOTYLEDONS			
Apiaceae			
Apium graveolens			Doubtful record, prob. in error for the native *A. prostratum.*
Daucus carota		x	Doubtful record, not recorded from the Sydney area now (Beadle *et al.*, 1972).
Asclepiadaceae			
Asclepias fruticosa			
Asteraceae			
Cotula coronopifolia		x	
Brassicaceae			
Lepidium didymus	*Coronopus didymus*	x	
Caryophyllaceae			
Cerastium vulgatum	*C. glomeratum*	x	
Scleranthus annuus			Doubtful record, this European species has never been recorded from Australia. Possibly confused with a native species of the Caryophyllaceae.
Silene anglica	*S. gallica*	x	
Euphorbiaceae			
Euphorbia peplus			
Fabaceae			
Vicia sativa		x	
Geraniaceae			
Erodium moschatum		x	
Lamiaceae			
Stachys arvensis			
Lythraceae			
Lythrum hyssopifolium		x	
Malvaceae			
Malva capensis	*Malvastrum capense*		Doubtful record, no specimen or other records (Britten, 1906).
Plantaginaceae			
Plantago major		o	
Primulaceae			
Anagallis arvensis		x	
A. coerulea		x	The blue forma of the preceding.

Table 1 (*Continued*)

Species as listed by Brown	Current name if different	Recorded early in S. Aust.	Comments
Rosaceae			
Fragaria vesca	?*Duchesnea indica*		
Solanaceae			
Datura	Prob. *D. stramonium*	x	
Nicotiana tabacum			Doubtful record, never having been recorded as naturalised in N.S.W. otherwise.
Physalis pubescens	*P. peruviana*	x	
Solanum sodomaeum	*S. hermanii*		
Urticaceae			
Urtica urens		x	

Table 2—Introduced plants in Victoria. 1856, adapted from "A catalogue of Plants common in the Colony of Victoria" compiled by Hannaford (1856).
x = naturalised in South Australia before 1855 (Kloot, 1983);
o = present in South Australia by 1850—see text and unpublished data of the author.

Species as listed by Hannaford	Current name if different	Recorded early in S. Aust.	Comments
MONOCOYLEDONS			
Alismataceae			
Alisma plantago	*A. plantago-aquatica*	x	
Juncaceae			
Juncus bufonius			
Poaceae			
Alopecurus geniculatus		x	
Avena fatua		x	
Briza minor		x	
Cynodon dactylon		x	
Dactylis glomerata			
Holcus lanatus			
Hordeum murinum	*H. leporinum* & *H. glaucum*	x	
Lolium perenne		x	
L. temulentum		x	
Phalaris minor		x	
Poa annua		x	
Sporobolus indicus	*S. capensis*		
Vulpia			*V. bromoides* was an early naturalisation in S.A. (Kloot, 1983).
Potamogetonaceae			
Potamogeton natans			
P. obtusifolius			Doubtful record as this species has never been recorded from Australia (Aston, 1973).
Ruppiaceae			
Ruppia maritima			

Table 2 (*continued*)

Species as listed by Hannaford	Current name if different	Recorded early in S. Aust.	Comments
DICOTYLEDONS			
Asteraceae			
Centaurea solstitialis			
Cotula coronopifolia		x	
Erigeron canadensis	*Conyza canadensis*		Possibly a misidentification of *C. bonariensis* which was recorded early in S.A. (Kloot, 1983) and Victoria (Bentham, 1867).
Hypochoeris glabra		x	
Onopordon acanthium		o	
Silybum marianum		x	
Sonchus oleraceus		x	
Taraxacum officinale			
Brassicaceae			
Capsella bursa-pastoris		x	
Lepidium ruderale			Name misapplied to native spp. and the introduced *L. africanum* (Kloot, 1983).
Nasturtium terrestre	*Rorippa palustris*	x	
Senebiera didyma	*Coronopus didymus*	x	
Sisymbrium officinale		x	
Caryophyllaceae			
Cerastium glomeratum		x	
Polycarpon alsinifolium	?*P. tetraphyllum*	x	
Sagina apetala			
Silene gallica		x	
Spergula arvensis		x	
Stellaria media		x	
Chenopodiaceae			
Chenopodium murale		x	
Convolvulaceae			
Calystegia sepium		x	
Fabaceae			
Ervum hirsutum	*Vicia hirsuta*	x	
Lotus corniculatus		x	
L. tenuifolius	*L. tenius*		Identity uncertain, as this species has never been collected from Victoria.
Medicago sativa		x	
Melilotus officinalis	?*M. indica*	x	These two species were often confused last century.
Trifolium filiforme			
T. procumbens	*T. campestre*		
T. repens		x	
Vicia angustifolia			
Gentianaceae			
Erythraea australis	*Centaurium minus* & *C. spicatum*	x	
Geraniaceae			
Erodium moschatum		x	
Lamiaceae			
Marrubium vulgare		x	
Prunella vulgaris		x	

Table 2 (*continued*)

Species as listed by Hannaford	Current name if different	Recorded early in S. Aust.	Comments
Lythraceae			
Lythrum salicaria			
Malvaceae			
Malva vulgaris	*M. neglecta*		
Plantaginaceae			
Plantago coronopus		x	
P. lanceolatum		o	
Polygonaceae			
Polygonum aviculare		x	
Rumex acetosella	?*R. angiocarpus*	x	
R. crispus		x	
Primulaceae			
Anagallis coerulea		x	Generally included as a forma of the following.
A. phoenicea	*A. arvensis*	x	
Rosaceae			
Alchemilla arvensis	*Aphanes arvensis*	x	
Rosa rubiginosa		x	
Scrophulariaceae			
Verbascum blattaria	*V. thapsus*	x	
V. virgatum			
Solanaceae			
Solanum nigrum		x	
Urticaceae			
Urtica dioica			Probably the native *U. incisa* to which it is very similar.
U. urens		x	

Table 3—Introduced plants in New Zealand before 1845, based on the lists of Richard (1832), Cunningham (1836-39) and Raoul (1846) and modified by comments of Allan (1937).
x = naturalised in South Australia before 1855 (Kloot, 1983);
o = present in South Australia by 1850—see text and unpublished data of the author.

Species as listed	Current name if different	Recorded early in S. Aust.	Comments
MONOCOTYLEDONS			
Poaceae			
Avena sativa		o	
Cynodon dactylon		x	
Phalaris canariensis		o	
Triticum repens	*Agropyron repens*		
DICOTYLEDONS			
Apiaceae			
Apium graveolens		o	Possibly in error for the native *A. prostratum* but this record accepted as correct by Webb (1978).

Table 3 *(continued)*

Species as listed	Current name if different	Recorded early in S. Aust.	Comments
Asteraceae			
Bidens pilosa			
Cotula coronopifolia		x	
Picris hieracioides		x	
Sonchus oleraceus		x	
Brassicaceae			
Alyssum maritimum	*Lobularia maritima*		
Brassica oleracea		o	
Nasturtium sylvestre	*Rorippa islandica*	x	The name *N. sylvestre* was misapplied by Richard (Allan, 1961).
Raphanus sativus		o	
Senebiera coronopus	*Coronopus squamatus*		
S. pinnatifida	*Coronopus didymus*	x	
Caryophyllaceae			
Arenaria media	*Spergularia marginata*	x	The name *A. media* was misapplied by earlier NZ authors (Allan, 1961).
Cerastium viscosum	*C. glomeratum*	x	
Stellaria media		x	
Convolvulaceae			
Calystegia sepium		x	
Fabaceae			
Medicago denticulata	*M. polymorpha*	x	
Ulex europaeus		o	
Geraniaceae			
Erodium cicutarium		x	
Plantaginaceae			
Plantago major		o	
Polygonaceae			
Rumex crispus		x	
R. obtusifolius			
Primulaceae			
Anagallis arvensis		x	
Rosaceae			
Fragaria vesca	*?Duchesnea indica*		
Solanaceae			
Solanum nigrum		x	
Urticaceae			
Urtica urens		x	

Table 4—Introduced plants first recorded on Lord Howe Island up to 1875 (after Pickard, 1984).

Species	Naturalised in S. Aust. before 1855 (Kloot, 1983)
MONOCOTYLEDONS	
Juncaceae	
Juncus polyanthemos	
Poaceae	
Digitaria sanguinalis	
Polypogon monspeliensis	Yes
Sporobolus africanus	
DICOTYLEDONS	
Asteraceae	
Bidens pilosa	
Conyza albida	Uncertain
Brassicaceae	
Capsella bursa-pastoris	Yes
Coronopus didymus	Yes
Caryophyllaceae	
Cerastium fontanum	
Stellaria media	Yes
Moraceae	
Morus alba	
Solanaceae	
Physalis peruviana	Yes
Verbenaceae	
Verbena bonariensis	

J. Adelaide Bot. Gard. 7(3): 233-247 (1985)

TAXONOMIC NOTES ON *HAKEA* SCHRADER (PROTEACEAE), MAINLY RELATING TO SOUTH AUSTRALIA

W.R. Barker

State Herbarium, Botanic Gardens, North Terrace, Adelaide, South Australia 5000

Abstract

Sect. *Grevilleoides* Benth. is in need of revision, the current species often being poorly distinguished. *H. ivoryi* Bailey is shown to be confined to Queensland, *H. eyreana* (S. Moore) D. McGillivray to the Simpson Desert and east of it, and *H. divaricata* L. Johnson, reinstated for South Australia, occurs in central arid Australia, possibly extending to central Queensland; *H. suberea* S.Moore and *H. cunninghamii* R. Br. are likely to be synonymous, the latter name having priority. Among *H. leucoptera* R. Br. and its allies the branching and indumentum of the rachis are important diagnostically; *H. leucoptera* is variable in floral indumentum throughout South Australia, sometimes has a drooping habit east of the Flinders Ranges, and encompasses South Australian material previously assigned to *H. kippistiana* Meissner; *H. tephrosperma* R. Br. is newly recorded for South Australia and its variability in south-east Australia and distinction from *H. leucoptera* is clarified; *H. vittata* var. *glabriflora* J. Black ex J.H. Willis, described from the Mt Lofty Ranges, is reduced to synonymy under *H. sericea* Schrader, which is likely to be naturalised there; a Victorian record of this variety was based on a specimen of *H. lissosperma* R. Br.

Introduction

The following notes explain modifications to the taxonomy of *Hakea* adopted in the forthcoming edition of the "Flora of South Australia" (Barker, in press) and a precursor list of species in the State (Barker 1984).

Visits to the National Herbarium of Victoria (MEL), the Australian National Herbarium (CANB), the British Museum (Natural History) (BM) and the Royal Botanic Gardens, Kew (K), study of specimens of *H. ivoryi* F.M. Bailey from the Queensland Herbarium (BRI), field observations in north-west South Australia and Northern Territory in 1978 and in north-east South Australia and south-west and central Queensland in 1984 have assisted in confirmation or clarification of some aspects.

Two main groups of *Hakea* are dealt with. In the corkwoods (Sect. *Grevilleoides* Benth.) some advances have been made towards the clarification of the taxonomy of South Australian species which have traditionally been placed in two groups defined by the preponderance of simple or compound leaves. In *H. leucoptera* and its allies, to which the common name needlewood is often applied, diagnostic traits separating the South Australian species are clarified and the misapplication of some names is corrected.

As a result of this study it is clear that these two natural groups of species, in particular Sect. *Grevilleoides*, would benefit from Australia-wide revision.

1. *Hakea* Sect. *Grevilleoides* Benth., *Fl. Austral.* 5 (1870) 490 (*Corkwoods*).

While the division of the corkwoods into a group with long simple leaves and another with short compound leaves has proved useful for some workers, not only in keys in floras (Bailey 1901; Black 1924, 1948), but also in the more detailed work of Blake (1963), the distinction between the two groups is by no means clear-cut. Blake (1963) himself mentions the tendency for the simple-leaved species to have sporadic compound leaves, this phenomenon occurring most commonly in *H. suberea* (see b. below). *H. ivoryi* has leaves which can be simple or compound, although by their shortness this species can be conveniently and, it seems, naturally grouped with the other taxa with short compound leaves. Only a future revision will show whether this division is truly natural.

In 1963, Blake reviewed the taxonomy of the simple-leaved corkwoods (*H. lorea* (R. Br.) R. Br. and its allies) on the basis of material from a limited number of herbaria. His notes on the morphology of the group have implications for the taxonomy of the compound-leaved species and as a result have been considered in the context of the corkwoods of South Australia and neighbouring regions as a whole. The sporadic glandular hairs which Blake recorded in *H. chordophylla* FvM. as new for the Proteaceae also occur occasionally in inflorescences of all the central Australian corkwoods. Occasional glabrous inflorescences occur in the three central-Australian compound-leaved taxa, but this character has neither other correlated morphological traits nor distinct geographical range, such that the character seems likely to occur within populations with eglandular-pubescent inflorescences. In the main, leaf scar characters, gland size and shape, pollen-presenter morphology, fruit shape and position of the seed in the valve show wide variability within the central Australian taxa and are rarely diagnostic, although Blake (l.c.) used these traits diagnostically in his group of taxa and in this region the compound-leaved species have a smaller fruit than the single predominantly simple-leaved species.

a. The compound-leaved corkwoods (the *H. eyreana-H. ivoryi* complex).

Apart from *H. ednieana* Tate, which has distinctive floral characters, there has been much confusion as to the taxonomy and geography of the other corkwoods in this complex in South Australia. In 1924 Black recognised only *H. intermedia* Ewart & Davies but commented upon the need for study of the corkwood group. He later (Black 1948) distinguished a second species *H. ivoryi* F.M.Bailey (1901) which had been described from south-west Queensland. *H. intermedia* was subsequently replaced by *H. divaricata* L.Johnson (1962) because *H. intermedia* was an illegitimate later homonym. *H. divaricata* in turn was replaced by *H. eyreana* (S. Moore) McGillivray (1975), based on priority of publication.

Black (1948) gave his two species quite different ranges in South Australia, *H. ivoryi* of south-west Queensland and north-western New South Wales occurring in the Musgrave Ranges in the north-west of the State, and the other species "*H. intermedia*" of central Australia, western New South Wales and Queensland occurring in the north-east of the State north of Coopers Creek and along the Diamantina River. His diagnostic characters were poor, only greatly overlapping leaf lengths being used in the key. However, from his descriptions, characters of leaf segment length and orientation seemed potentially more reliable. Confusion in herbarium specimen identification and publication resulted, as for example in Boomsma (1972, 1981).

Mr C.D. Boomsma (pers. comm. 1982) has since questioned the application of the name *H. ivoryi* to South Australian populations on the basis of its very different foliage as figured in the protologue (Bailey 1901).

Having studied a wide range of material from South Australia and Northern Territory, with additional specimens from New South Wales and Queensland, I come to the conclusion that there are several taxa worthy of distinction within the compound-leaved corkwoods of the central and eastern arid regions of Australia, each with separate or divergent geographical ranges.

Overall, these compound-leaved corkwood species are poorly distinguishable. Unless further diagnostic characters can be discerned, a future revision may show them to be better treated as subspecies of a widespread polymorphic species. This would emphasise the somewhat greater distinctiveness of *H. ednieana*.

Key to the compound-leaved corkwoods in central and eastern arid Australia

1a. Perianth with tube in mature bud 2-5 mm long, straight, the limb slightly oblique, pistil 8.5-11 mm long, style ± straight, pollen-presenter ± erect. [*Branchlets and leaves white-pubescent, (? finally) glabrescent. Leaves 2-7 cm long, petiole 0.6-4 cm long, final segments 1-14, spreading, 0.15-3.6 cm x 0.7-1.8 mm, mucro 1-3 mm long*] .... *H. ednieana*

1b. Perianth with tube in mature bud 5.5-10 (-12) mm long, recurved towards apex such that limb down-turned, pistil 18.5-28 (-30) mm long, style initially recurved, finally straight, pollen-presenter oblique to almost lateral.

2a. Branchlets densely tomentose and leaves densely pubescent over many nodes, finally both glabrescent. Rachis usually densely tomentose, rarely glabrous.

3a. Lateral width of fruit 1.7-2 cm. Leaves (when divided) 13-30 cm long, [*petiole 4-18 cm long, final segments 2-5, narrowly spreading, 1.5-17 cm x 1.3-2.5 mm, mucro 1.5-7 mm (fragile !)*] .... *H. suberea*

3b. Lateral width of fruit c. 1-1.2 cm. Leaves 1.5-10 (-12) cm long.

4a. Branchlets stout, raised-tomentose, rarely subglabrous. Leaves always compound, the petiole 0.8-2.5 (-4.5) cm long, final segments 4-15, 0.9-1.5 mm diameter. Gland (2-) 2.7-3.2 mm long. Shrub or small tree to 2-4 (-6) m high .... *H. eyreana*

4b. Branchlets slender, appressed-pubescent, sometimes with scattered hairs with raised arms. Leaves usually to sometimes simple on ?most plants of a population, on some plants entirely compound; when compound, the petiole (1-) 1.5-4 (-7) cm long, final segments 1-4 (-7), (0.5-) 0.6-1.2 (-1.4) mm diameter. Gland (0.6-) 1.3-2.5 (-3) mm long. Shrub or usually tree 2-12 m high .... *H. ivoryi*

2b. Branchlets pubescent at first few nodes, elsewhere usually glabrous, sometimes sparsely, rarely densely pubescent; leaves glabrous or sparsely pubescent, glabrescent. Rachis often pubescent, usually sparsely, sometimes densely so, sometimes glabrous. [*Leaf mucro 0.5-3.5 (-5) mm long*].

5a. Leaves (7-) 9-16 (-20) cm long, petiole 2.5-9 cm long, final segments (1-) 3-13 (-16), i.e. often as few as 3, (0.3) 2-9 (-12) cm long .... *H. divaricata*: race "*Southern*"

5b. Leaves (4-) 5-9.5 (-10) cm long, petiole (1.5-) 2-4 (-5) cm long, final segments (3-) 5-18 (-22), i.e. rarely 3, (0.05-) 0.2-6 (-6.5) cm long .... *H. divaricata*: race "*Northern*"

H. ednieana Tate, Trans. R. Soc. S. Austral. 7 (1885) 70.

Type citation: ". . . stony slopes of the Aroona Range, bordering the Basin of Lake Torrens on the east. *R.Tate*." *Possible syntype*: *Anon. 382*, s.dat., MEL 642951 (fruits only; in Mueller's hand: "Hakea Ednieana Tate, Sent by Prof. R.Tate!").

Confined in South Australia to the northern Flinders Ranges, this species is distinctive both morphologically and, at least in South Australia, geographically. I am uncertain of its reported occurrence in far north-western New South Wales (Cunningham et al. 1981; Jacobs & Pickard 1981) as I have seen no specimens from there with fully-opened flowers, which are necessary to distinguish it from other compound-leaved species in the region. The photograph in Cunningham et al. (1981) is not of *H. ednieana* but of *H. eyreana*, recognised by its oblique pollen-presenter, stout branchlets and many-segmented leaves.

Selected specimens examined

(Number of specimens seen are given when not all specimens are cited).

SOUTH AUSTRALIA. LAKE EYRE BASIN: *Hornsby 49*, 11.iv.1981, Moolawatana Station (AD sterile). FLINDERS RANGES (42 specimens): *Anon. (Herb. Tate) s.n.*, s.dat., Aroona Range (AD 98325160; material with flowers, no fruits, possibly a topotype but not a syntype); *Bakker s.n.*, 7.vii.1973, Brachina Gorge, Oraparinna (AD 97336004); *Eichler 19635*, 26.x.1967, Balcanoona near Nudlamutana Well along track leading W into mountain (AD); *Kuchel 2973*, 18.x.1971, Arkaroola Sanctuary, c. 25 km E of headquarters (AD); *Mollemans 1124*, 6.x.1981, creek leading up to Freeling Heights Plateau, 4.5 km NW of Paralana Hot Springs (AD; this specimen has sparser

than normal indumentum on rachis and flowers and more or less erect, twisted hairs, characters not evident in the several other specimens from the Paralana Springs area); *Mollemans 1132*, 6.x.1981, same locality (AD). EASTERN (3 specimens): *Rogers s.n.*, 21.x.1967, 10 miles E of Martins Well (AD 97006202 ex NT 25897).

H. ivoryi Bailey, Qld Fl. (1901) 1346, t. 59.

Syntypes: *J.F. Bailey s.n.*, xii.1896, Bingara, (BRI 11492) ; *Ivory s.n.*, i.1901, Charlotte Plains, (BRI 11491).

H. ivoryi is a taxon confined to south-western Queensland and north-western New South Wales. Its leaves are much shorter than the misleading "usually under 6 in. long" stated in the protologue (Bailey 1901) implies. Cunningham et al. (1981), also give a leaf length of 5-18 cm; they possibly confused *H. ivoryi* with a simple, long-leaved corkwood.

H. ivoryi differs from other corkwoods with relatively short, compound leaves in its high frequency of simple leaves. These leaves are very slender and flexible. In the population *Barker 4671* such leaves were predominant on most of the trees; the divided leaves on these trees tended to have very few (up to 3) segments which were similarly slender and flexible. Other plants, including the highest tree, had stiffer divided leaves with up to 7 segments. Leaves of this latter type were not seen by Bailey (1901). They have been noted, however, on "suckers" (*Smith 838 & Everist*), but whether these developed from trees with similar or fewer segmented leaves was not indicated. In the collections seen, there was a higher proportion with simple or few-segmented leaves than with predominantly several-segmented leaves, indicating that the pattern of leaf division may be similar throughout the range of the species. Population samples are required to confirm this, particularly in regions such as north-western New South Wales where *H. eyreana* and *H. ivoryi* may overlap in distribution.

Specimens examined

QUEENSLAND. GREGORY SOUTH: *MacGillivary 1018*, 8.ix.1923, Bransby (BRI). WARREGO: *Althofer 37*, x.1971, 32 km from Charleville on Cunnamulla road (BRI); *J.F. Bailey* xii.1896 (syntype); *Barker 4871 & Chinnock*, 26.ix.1984, c. 13 km by road N of Yowah Opal Field store, c. 3 km by road S of turnoff to 'Bundilla' and 'Jandell', c. 14 km by road SW of 'Alroy' (AD & duplicates); *Bell 515*, 1.xii.1971, near Charleville (BRI); *Clemens s.n.*, x.1945, near Charleville (BRI 242962); *Ebersohn E210*, 14.iv.1962, 50 miles on Cunnamulla-Barringun Road (BRI); *Ivory* i.1901 (syntype); *Smith 838 & Everist*, 16.x.1940, c. 9 miles NW of Charleville (BRI, CANB, MEL). MARANOA: *Roe 736*, 12.x.1947, 30 miles W of Bollon on Cunnawilla [?Cunnamulla] Road (CANB); *Roe 908*, 24.x.1946, 59 miles W of St George on Bollon Road (CANB); *Williams 73*, Boatman Road, 33 miles N of Cunnamulla Road Junction (BRI).

NEW SOUTH WALES. NORTH WESTERN PLAINS: *Moore 3579*, 15.x.1964, between Enngonia and Bourke (CANB). FAR NORTH WESTERN PLAINS: *Blaxell 601*, 5.xi.1971, 'Wirranya', W of Bourke (BRI); *Boorman s.n.*, x.1912, Waverley Downs (AD 9832535, AD 97525233 p.p. Herb. Black, BRI 24965); *Dalton s.n.*, x.1906, Wanaaring, Paroo River, (MEL 642899, AD 97525226 p.p. Herb. Black); *Moore 4715*, 8.xii.1966, 'Pelora', about 60 miles NW of Louth (CANB); *Moore 5656*, 12.xi.1969, 'Mt Mulyah' about 50 miles NW of Louth (CANB); *Moore 6555*, 7.v.1974, 'Pelora', 30 miles NW of Louth (CANB, 3 sheets).

H. eyreana (S. Moore) D. McGillivray, Telopea 1 (1975) 30.

Grevillea eyreana S.Moore, J. Linn. Soc. (Bot.) 45 (1920) 210, basionym.

Holotype: *Capt. Sturt s.n.*, s. dat., [South Australia, Lake Eyre district,] Lat. 27°30′ (sic!), on sand hills BM.

H. intermedia auct. non Ewart & O.B. Davies: J. Black, Fl. S. Austral. (1924) 160 p.p., non Hook.

H. divaricata auct. non L.Johnson: Boomsma, Native Trees S. Austral. (1972) 197, p.p.

H. ivoryi auct. non Bailey: Boomsma, Native Trees S. Austral. (1981) 262, p.p.

H. eyreana is restricted to the Cooper-Diamantina river basins and the margins of the Simpson Desert in north-eastern South Australia and south-eastern Northern Territory, extending into neighbouring parts of New South Wales and Queensland. It is distinguished from other compound-leaved corkwoods by its woolly-tomentose branchlets and its shortly petiolate leaves which tend to be more greatly divided into shorter segments than in any other species. Some material (e.g. *Barker 4625*), both at a flowering and a fruiting stage, may have subglabrous branchlets, but this is rare and in some cases the older parts of the branchlets show remnants of the persistent raised tomentum typical of the species. This lack of hairs may therefore be a rare phenotypic phenomenon.

Selected specimens examined

SOUTH AUSTRALIA. LAKE EYRE BASIN (25 specimens seen): *Anon. (S. Aust. Pastoral Board) s.n.*, 5.vi.1957, Cordillo Downs (AD 97630015); *Badman 325*, 13.vii.1981, Kooncherra Sandhill, 1 km NW of Birdsville Track (AD, CANB, NSW; erect ?glandular hairs in inflorescence); *Barker 4621-4624 & Chinnock*, 14.ix.1984, c. 11½ km by road ENE of Patchawarra Creek crossing and bore, c. 68 km by road N of Innamincka store, on road to 'Cordillo Downs' (AD & duplicates); *Barker 4625*, 15.ix.1984, Montkeleary ("Montecleary") Creek crossing by 'Cordillo Downs'-Innamincka road, c. 4 km by road SSE of southern turnoff to 'Arrabury' (AD & duplicates); *Donner 5346*, 28.viii.1975, c. 30 km E of Cordillo Downs, c. 4 km W of Arrabury Homestead (AD); *Jackson 2744*, 13.viii.1975, Clifton Hills Station, c. 40 km SSE of Koonchera Waterhole (AD; inflorescence glabrous); *Williams 8123*, 23.v.1976, Innamincka township (AD).

NORTHERN TERRITORY. CENTRAL AUSTRALIA SOUTH: *Crocker (Simpson Desert Expedition) 1*, 29.v.1939, plain, W of Andado Station (AD); *Crocker (Simpson Desert Expedition) 2*, 12.vi.1939, between sandridges, camp 7 (AD); *Crocker (Simpson Desert Expedition) 3*, 18.vi.1939, Camp 10 (AD).

QUEENSLAND. GREGORY SOUTH: *Barker 4636*, 15.ix.1984, c. 75 km by road ENE of Betoota, c. 21 km by road ENE of 'Arrabury' turnoff, on Birdsville Developmental Road to Windorah (AD & duplicates; inflorescence with glandular hairs).

H. divaricata L.Johnson, Contrib. N.S.W. Natn. Herb. 3 (1962) 93.

H. intermedia Ewart & O.B. Davies, Fl. N. Terr. (1917) 86, basionym, non Hook.

Syntypes: *G.F.Hill 108*, 21.iii.1911, 37 miles E of Hermansburg (MEL, AD); *G.F. Hill 111*, 21.iii.1911, near Jay Gorge, Jay River (MEL); *G.F.Hill 287a*, 60 miles N.E. C[amp] 2, [Lander River, NE of Stuarts Bluff Range] (MEL, AD).

H. ivoryi Bailey var. *glabrescens* J. Black, Trans. R. Soc. S. Austral. 61 (1937) 242.

Syntypes: *Cleland s.n.*, 4.ix.1930, MacDonald Downs Station, Fraser River (AD 97230203, AD 96046069 p.p.); *White s.n.*, 19.viii.1913, Crown Point, Finke River (AD 96046069 p.p., AD 97525234 p.p.).

H. ivoryi auct. non Bailey: J. Black, Fl .S. Austral. (1948) 264

H. eyreana auct. non (S. Moore) D. McGillivray: Boomsma, Native Trees S. Austral. (1981) 261, p.p.

With *H. ivoryi* restricted to the eastern arid regions, the name *H. divaricata* L. Johnson must now be reinstated to the central Australian species to which *H. ivoryi* has been often misapplied. It should be noted that some herbaria, e.g. NT, have continued to use *H. divaricata* for this species. It is distinguished by its glabrous or rapidly glabrescent red-brown branchlets.

H. divaricata seems divisible into two races tending to occur respectively in the northern and southern parts of its overall range. From the Musgrave, Mann and Tomkinson Ranges of north-west South Australia to the MacDonnell Ranges, Northern Territory, is a race with leaves with ultimate leaf segments tending to be fewer and longer than in other consistently compound-leaved corkwood species. From the MacDonnell Ranges northwards and on the western margin of the Simpson Desert is a shorter-leaved race with shorter more narrow ultimate segments, in these characters approaching *H. eyreana*. A population *Barker 4708* from central Queensland, south of Winton, has close affinities with this race, but alternatively

it may come from an intergrade with *H. chordophylla*, a species with predominantly simple, long leaves which occurs in the same region. Study of populations and a wider range of collections is required for the pattern of variation in the various diagnostic traits to be accurately recorded and to determine if a formal taxonomic breakdown of the variation is warranted.

The southern race of *H. divaricata* approaches compound-leaved forms of *H. suberea* which occurs sympatrically, but specimens of the latter can readily be distinguished by their persistently woolly-pubescent branchlets, longer leaves and broader fruits in lateral view. For further discussion see under *H. suberea.*

Selected specimens examined

H. divaricata L.Johnson race "*Northern*"

NORTHERN TERRITORY. CENTRAL AUSTRALIA NORTH (13 specimens, none with glabrous inflorescence): *Chippendale 2052*, 17.v.1956, Napperby Creek, NW Stockroute (AD); *Hill 287a* (syntypes of *H. intermedia* Ewart & O.B. Davies); *Nelson 1567*, 26.ix.1967, 3 miles S of Eurobra Gap, Jinka Station (AD). CENTRAL AUSTRALIA SOUTH (10 specimens, 3 with glabrous inflorescences): *Country Womens Assoc. per Ashby 59*, 1.x.1957, Alice Springs area (AD; inflorescences glabrous); *Hill 108* (syntype of *H. intermedia* Ewart & O.B. Davies); *Lazarides 5765*, 21.viii.1956, 31 miles NNW of Alice Springs township (AD; photos of habit, bark); *Nelson 975*, 12.iii.1964, Tropic of Capricorn, 13 miles S of Kintore Range (AD).

Specimen with affinities to *H. divaricata* L.Johnson race "*Northern*"

QUEENSLAND. GREGORY NORTH: *Barker 4708*, 19.ix.1984, near Wirribi (2) Bore, c. 5 km by road SSW of 'Colston' turnoff, c. 45km direct SSW of Winton, on 'Opalton' road (AD & duplicates).

H. divaricata L.Johnson race "*Southern*"

SOUTH AUSTRALIA. NORTH WEST (23 specimens, none with glabrous inflorescences): *Barker 3334*, 7.ix.1978, c. 2 km by road NNE of Pipalyatjara-Putaputa road along road to Waltjitjata; Tomkinson Ranges (AD); *Boomsma 15*, 28.ix.1974, Wardulka Valley, Everard Ranges (AD); *Weber 190*, 30.x.1966, Musgrave Ranges, Mt Harriet Road, c. 25 km S of Musgrave Park Station (AD).

WESTERN AUSTRALIA. WARBURTON (3 specimens, none with glabrous inflorescence): *Kuchel 200*, 2.viii.1962, Warrabri Gorge, SW side of Rawlinson Range, c. 15km NW of Giles (AD). GREAT VICTORIA DESERT: *Tietkins s.n.*, 1889, Lindsay Hills (AD 97733688).

NORTHERN TERRITORY. CENTRAL AUSTRALIA NORTH: *Cleland* 4.ix.1930 (syntypes of *H. ivoryi* var. *glabrescens* J.Black; inflorescences glabrous). CENTRAL AUSTRALIA SOUTH (9 specimens, 2 with glabrous inflorescences): *Correy s.n.*, vi.1964, Ayers Rock (AD 96532148); *Lothian 386*, vii-viii.1954, MacDonnell Ranges, Province's Gap (AD); *White* 19.viii.1913 (syntype of *H. ivoryi* var. *glabrescens* J. Black; inflorescence glabrous).

H. divaricata L. Johnson (race indeterminable).

(6 specimens from the Central Australia North and South regions of Northern Territory, including *Hill 111*, syntype of *H. intermedia* Ewart & O.B. Davies).

H. suberea S. Moore: compound-leaved form

(See under following section).

b. The simple-leaved corkwoods (*H. suberea* S. Moore and its allies).

In the past only one species has been recognised for South Australia's far north-western regions in this group of species. It was formerly known as *H. lorea* (R. Br.) R. Br. (e.g. Black 1924, 1948), but Blake (1963) showed that this species was confined to north-eastern and eastern Queensland and substituted the currently used name *H. suberea* S.Moore for the species in South Australia.

The present study has concentrated on the taxonomy and nomenclature of this species. Detailed examination of material from the central arid regions of Australia, shows there to be the one relatively homogeneous species.

H. suberea S. Moore, J. Linn. Soc. (London) 34 (1899) 223.

Type citation: "Specimens of the same tree were obtained by Mr. Helms of the Elder Expedition in the Cavanagh and Barrow Ranges . . . Seen from the Black Gin soak, between Goongarrie and Mt Margaret, northwards to . . . high granite rocks fourteen miles north of Lake Darlot . . . My specimen — unfortunately only a single one and not very good — agrees perfectly with that of the Elder Expedition in the Kew Herbarium." *Isosyntypes*: *Helms s.n.*, 4.viii.1891, near Camp 33 near Barrow Ranges (MEL 643557); *Helms s.n.*, 17.viii.1891, near Barrow Range, MEL 643560, ?AD 96236037 p.p. (Camp 33). *Possible isosyntypes*: *Helms s.n.*, 29.v.1891, near Everard Ranges (MEL 643561); *Helms s.n.*, 30.v.1891, near Everard Ranges, K, AD 96236037 p.p., ?AD 96236036 p.p. None of the syntypes referred to in the protologue could be traced at K or BM.

?*H. cunninghamii* R. Br., Suppl. Primum Prod. Fl. Nov. Holl. Prot. nov. (1830) 26.

Syntypes: *A. Cunningham 108*, 16.ii.1818, Capt. King's 1st voyage, north-west coast of Australia, Exmouth Gulf, Bay of Rest, lat. 22° 17′ S, long. 114° 20′ E (BM, 2 sheets; K).

H. lorea auct. non (R. Br.) R. Br.: FvM. & Tate, Trans. R. Soc. S. Austral. 16 (1896) 362; J. Black, Fl. S. Austral. (1924) 160; J. Black, Fl. S. Aust. (1948) 264.

In the central arid regions of Australia this species has long stout leaves and branchlets and inflorescences covered by a woolly tomentum composed of T-shaped hairs with upturned arms. It is closely associated with the mountain systems and inselbergs in the region.

Leaves divided into a few long segments occur sporadically on a substantial proportion of specimens from central Australia, although wholly simple-leaved specimens are more common. Blake (1963) commented that compound leaves occurred more frequently in *H. suberea* than in other species of the *H. lorea* group. Past identifications of material in AD and NT, notably by the late J.Maconochie, a *Hakea* specialist, indicated indecision as to whether these were variants of *H. suberea* or hybrids with *H. divaricata*, although Maconochie appears from more recent determinations to have decided that the former was the case. There is little doubt that this is indeed so, for the three main characters separating *H. suberea* from sympatric populations of the southern race of *H. divaricata* hold true. The northern race of *H. divaricata* is even more distinct from *H. suberea*.

In western Western Australia, from Laverton north-west to the Pilbara region, there is, in a relatively sparse sample of specimens, evidence of a trend from the leaves and indumentum of the central arid-zone populations in the south to more slender leaves and an appressed silky indumentum, owing to the shorter straight arms of the T-shaped hairs, in the north. All specimens examined from the region are listed below with these characters.

The slender leaves and silky appressed pubescence evident in material from north-west Western Australia were attributed by Blake (l.c.) to *H. fraseri* R. Br. of eastern Australia and, at least as to the latter character, *H. cunninghamii* R.Br., which he cited as restricted to northern Australia. Material in AD which Blake saw from the Pilbara and neighbouring regions with these characteristics, he assigned to *H. suberea*. Surprisingly he missed the anomaly that the type locality of *H. cunninghamii*, being in Exmouth Gulf, was in the same region, far away from the northern Australian localities to which he restricted the species.

Apart from the degree of appression of the indumentum, Blake's (l.c.) characters distinguishing *H. cunninghamii* from *H. suberea* break down in the material seen. All fruit-bearing specimens seen of plants with the *H. cunninghamii* indumentum type have the seed cavity displaced to one side and the fruit sometimes curved at the apex, characters attributed by Blake to *H. suberea*. Furthermore, the torus seems equally oblique in the two species. The

character of channelling of the leaf towards the apex does not characterise *H. suberea* in central or western Australia. There is a tendency for narrower leaves in western Western Australian material, but the character does not correlate with the indumentum variation. Thus, the great variability in characters described by Blake (l.c.) in the simple-leaved corkwoods applies just as much to fruit shape and seed cavity position in this complex.

When the specimens from the central and western arid regions of Australia are brought together they form a relatively homogeneous group. Through his confusion about the range of *H. cunninghamii*, Blake himself circumscribed *H. suberea* in this way. It seems likely that following examination of all types and a study of all Western Australian material the species will have to be renamed *H. cunninghamii*, for reasons of priority. Whether the species is conspecific with the northern Australian populations to which Blake assigned the name *H. cunninghamii* will require examinations of more than the few specimens seen for this study.

Specimens examined

H. cunninghamii R. Br.

WESTERN AUSTRALIA. PILBARA (5 seen): *Boomsma 16*, 2.vii.1976, Dampier (AD); *Boomsma 624*, 6.viii.1980, 2 km SW of Paraburdoo (AD); *Jackson 2912*, 18.viii.1977, Hamersley Range National Park, Fig Tree Soak, c. 10 km by road SW into Yampire Gorge from Wittenoom-Roy Hill road (AD). CARNARVON: *Ashby 3889*, 18.vii.1971, c. 80 km E of North West Coast Highway, on Gascoyne Junction Road (AD); *A. Cunningham 108* (syntypes of *H. cunninghamii*). ASHBURTON: *Speck 78*, 15.vii.1958, 10 miles S of Berringarra (AD).

NORTHERN TERRITORY. VICTORIA RIVER: *R.M. Barker 202*, 20.iv.1983, No. 12 Government Bore, 2 km off Buchanan Highway (AD, NSW); *Shaw 852*, 3.vi.1967, c. 3 km E of the Victoria River Crossing (AD).

H. suberea S.Moore: simple-leaved specimens

SOUTH AUSTRALIA. NORTH WEST (37 specimens): *Helms* 29.v.1891, 30.v.1891 (? isosyntypes of *H. suberea*); *Whibley 6631*, 31.viii.1978, Mt Lindsay inselberg; northern side near the base (AD); *Wilson 2571*, 10.viii.1962, foot of Mt Woodroffe (AD). LAKE EYRE BASIN (6 specimens): *Badman 246*, 5.vi.1980, Carpamoongana Waterhole, Hamilton Station (AD); *Helms* 20.v.1891 (?isosyntype of *H. suberea*).

WESTERN AUSTRALIA. PILBARA/ASHBURTON: *Burbidge 6039*, 8.v.1958, Roy Hill-Mundiwindi (60 miles S of Roy Hill) (AD; slender leaves but raised pubescence). AUSTIN: *Speck 607*, 4.ix.1957, 13 miles NW of Meekatharra, (AD; slender leaves but raised pubescence). GREAT VICTORIA DESERT: *Crisp 5849, Taylor & Jackson*, 15.ix.1979, c. 30 km W of Plumridge Lakes, 3 km N of Salt Creek airstrip (AD; stout leaves, raised pubescence); *Toelken 6058*, 9.ix.1979, 23 km ENE of Laverton (AD; slender leaves but raised pubescence). SOUTH WEST INTERZONE: *Young s.n.*, Ularing (MEL 643851). WARBURTON (7 specimens, all stout leaved and with raised pubescence): *Chinnock 613*, 29.viii.1973, 22.5 km E of Warburton Mission (AD); *Helms* 4.viii.1891, 17.viii.1891, (isosyntypes of *H. suberea*); *Kuchel 285*, 4.viii.1962, c. 65 km NW of Giles (AD).

NORTHERN TERRITORY. CENTRAL AUSTRALIA NORTH: *Maconochie 383*, 13.vii.1967, 36 miles W of Harts Range Police Station (AD). CENTRAL AUSTRALIA SOUTH (18 specimens): *Donner 4301*, 20.viii.1973, Mount Cavenagh, c. 17 km SW of Kulgera Homestead (AD); *Lazarides 5195*, 7.v.1955, Strangway Mountains, 4.5 miles NE of Yambah Station (AD; habit photo); *Nelson 1514*, 5.vii.1967, 20 miles NW of Alice Springs, N side of Macdonnell Ranges (AD).

H. suberea S.Moore: specimens with one or more compound leaves.

SOUTH AUSTRALIA. NORTH WEST: *Cleland s.n.*, 13.viii.1933, Erliwanjawanja, Musgrave Ranges (AD 96807289); *Cleland s.n.*, 17.vi.1958, Cave Hill, Western Musgrave Ranges (AD 966080696); *Turvey s.n.*, 23.iv.1966, Ernabella (AD 97628083).

WESTERN AUSTRALIA. WARBURTON: *Cleland s.n.*, 22.vi.1960, Giles Creek, S of Rawlinson Range (AD 968071043).

NORTHERN TERRITORY. CENTRAL AUSTRALIA NORTH: *Ising s.n.*, 21.vi.1933, 50 miles NE of Alice Springs (AD 97647358); *Maconochie 386*, 13.vii.1967, 62 miles W of Harts Range Police Station (AD). CENTRAL AUSTRALIA SOUTH (17 seen): *Henshall 2906*, 26.iii.1980, Petermann Ranges Reserve, Chirnside Creek (AD); *Lothian 82*, 1954, Standley Chasm (AD); *Munir 5139*, 23.viii.1973, in gorges of Mt Olga (AD); *Nelson 1558*, 21.ix.1967, Harry Creek, 33 miles N of Alice Springs (AD).

2. *H. leucoptera* R.Br. and its allies (*Needlewoods*).

Sect. *Hakea* Ser. *Pubiflorae* Benth., Fl. Austral. 5 (1870) 491, p.p. (at least as to *H. kippistiana* and *H. vittata*).

Sect. *Hakea* Ser. *Glabriflorae* Benth., Fl. Austral. 5 (1870) 492, p.p. (at least as to *H. leucoptera* and *H. cycloptera*).

While a formal taxonomic subdivision of Sect. *Hakea* which adequately reflects the relationships of its many species has yet to be proposed, there is a group of species closely allied to *H. leucoptera* characterised by simple rigid terete leaves, umbellate inflorescences of small flowers with oblique discoid pollen-presenters, and fruits with a porrect beak and style-end, which are sometimes flanked by two prominent apical horns. The representatives of this group, recognised to date as occurring in South Australia (Black 1948; Eichler 1965) have been *H. leucoptera* R.Br., *H. kippistiana* Meissner, *H. cycloptera* R.Br., *H. vittata* R.Br. and *H. vittata* var. *glabriflora* J.Black.

The ability to distinguish to needlewoods recognised here has been enhanced by characters of the inflorescence previously little used in this group. The rachis of each species has its own characteristic patten of branching and indumentum, *H. leucoptera* having a simple, relatively long rachis with a woolly white pubescence, *H. tephrosperma* a simple short rachis with an appressed brown pubescence, *H. sericea* a short simple rachis with a white raised pubescence, *H. vittata* a rachis with 1-3 short branches with an evenly appressed brown pubescence, and *H. cycloptera* with similar short rachis branches, up to 5 together, but often borne on remnants of rachises from prior year(s) and with a white sericeous pubescence often mixed with brown hairs. Flower number in the inflorescence, and pedicel and tepal indumentum are also of importance.

Key to the South Australian needlewoods

1a. Tepals glabrous outside. [*Rachis white-pubescent*].

2a. Pedicels sparsely white, ± appressed puberulent. Leaves grooved below near base. [*Rachis simple or obscurely compound, 0.3-0.8 (-2.5) mm long*] .... *H. sericea*

2b. Pedicels glabrous. Leaves not grooved.

3a. Rachis white woolly puberulent, simple, sometimes with 1 or 2 basal buds rarely developed into branches, 6-14 mm long. Flowers 18-45; perianth tube 3-4.5 mm long. Fruit 1.7-3.2 cm long; seed wing cream to brown-white, decurrent on one side only. Shrub to tree 1-8 m high .... *H. leucoptera* (p.p.)

3b. Rachis white-sericeous, sometimes with brown hairs, simple or shortly branched, 0.5-3 mm long, sometimes up to 5 together on branches of prior year(s) and 1-10 mm long. Flowers 1-14; perianth tube 4-6.5 mm long. Fruit 2.5-4 cm long; seed wing brown to brown-black, decurrent on both sides (narrower on one side). Shrub 0.3-1.3 m high .... *H. cycloptera*

1b. Tepals hairy outside.

4a. Rachis white woolly pubescent, simple or with 1 or 2 basal buds sometimes developed into branches, 6-14 mm long. Flowers 18-45; perianth with raised white pubescence at least on limb, tube 3-4.5 mm long .... *H. leucoptera* (p.p.)

4b. Rachis densely ± appressed brown pubescent, simple or compound and knob-like with up to 4 branches, 0.5-3 mm long. Flowers 1-22; perianth with appressed white and/or brown hairs at least on limb, tube 4-6.5 mm long.

5a. Rachis simple. Flowers 6-22. Fruit smooth or verrucate, dehiscing fully down both sides. Leaves often hooked at apex, sometimes straight. Shrub to small tree, without witches-broom galls .... *H. tephrosperma*

5b. Rachis compound, of up to 4 branches, but a very short knob. Flowers 1-8 (-14). Fruit smooth or with broadly folded surface, dehiscing partly down one side, fully down the other. Leaves straight. Small shrub with witches-broom galls .... *H. vittata*

H. leucoptera R. Br., Trans. Linn. Soc. London 10 (1810) 180.

Type citation: "In Nova Hollandiae ora australi; Flinders' Land: ad margines sylvarum prope radices montium" [i.e. at base of Mt Brown] *Syntypes*: *R. Brown s.n.* [*Iter Australiense 3376*], 1802, Inlet XII, South Coast (BM, 2 sheets; K; MEL 64322).

?*H. kippistiana* Meissner, Hookers' J. Bot. Kew Gard. Misc. 7 (1855) 115.

Probable holotype: *Drummond Ser. 5, suppl. no. 14*, s. dat., Swan R[iver] (K, "Presd. by W.W. Saunders Esq. F.L.S.") *Isotypes*: BM ("1848"), K, MEL 642215, MEL 642216, MEL 642217.

Black (1948) distinguished *H. leucoptera* and his *H. kippistiana* on the absence or prescence of indumentum on the outer surface of the perianth and pedicel; earlier (Black 1924), he had distinguished the two at a varietal level. In the material seen flowers may be completely glabrous or have a sparse to dense, appressed silky pubescence. Both character states are distributed widely in South Australia and Northern Territory, so that it seems probable that the character may vary within populations, as is evident from *Badman 219*, which represents a sample from a population near Lake Eyre (the only other population sample available with flowering specimens, *Ulyatt 109-111* from near Alice Springs, has consistently glabrous flowers). It is noteworthy that, from both the material seen in AD and MEL and published descriptions (Willis 1973; Cunningham et al. 1981; Beadle 1982), *H. leucoptera* in the eastern States has glabrous flowers; it is possible however that some hairy-flowered specimens not seen from New South Wales could have been placed under *H. tephrosperma* (q.v.), with which material of *H. leucoptera* from New South Wales and Victoria has sometimes been confused.

H. leucoptera is also variable in habit, existing most commonly as a tall well-shaped shrub with many ascending main stems (e.g. *Pfeiffer 2*, *Barker 3515*, *Lazarides 6007*), but also, at least in the eastern margins of the Flinders Ranges, as a mis-shapen crooked tree with twisted and irregularly directed branches (e.g. *Pfeiffer 3, 9*). Its fruits also vary from having a quite prominent pair of horns on either side of the apex to the more normal state in which they are reduced to obscurity.

I have concluded, therefore, that apart from in the Renmark area (see under *H. tephrosperma* below) this complex in South Australia is a single variable species to which the name *H. leucoptera*, being the earlier published name, must be applied. This conclusion was adopted by George (1981) following correspondence. Study of type material of the *H. leucoptera* from the southern Flinders Ranges and *H. kippistiana* from Western Australia shows the two probably to be conspecific. A range of material, including fully opened flowers, from the type locality of the latter is needed to confirm this. While the rachis of the *H. kippistiana* types is appressed-puberulent, the pedicels, and base and limb of the perianth in bud are sparingly pubescent as in some South Australian material.

Even if the two types prove to belong to different species, *H. leucoptera* is the correct name for the South Australian species.

Selected and cited specimens

(*Glabrous* and *hairy* refer to the pedicel and perianth; habit characters are also referred to in the Eastern region of South Australia).

SOUTH AUSTRALIA. NORTH WEST (15 specimens): *Anon. (S.Aust. Pastoral Board) s.n.*, 2.x.1955, The Currie Creek (AD; *glabrous*); *Weber 250*, 4.xi.1966, Wantapilla Bore, E end of Everard Ranges (AD; *hairy*). LAKE EYRE BASIN (55 specimens): *Badman 219*, 12.xi.1979, Lake Eyre South, 18 km E of Curdimurka (AD, 2 sheets; MEL, HO, LSU, SIU; *glabrous, sparsely hairy*); *Badman 223*, 24.x.1979, 28 km S of Oolgowa Water Hole, Macumba Station on W edge of Simpson Desert (AD, H, HO, GZU; *hairy*); *Lothian 1469*, 9.viii.1963, Simpson Desert, c. 12 km E of base camp which is c. 61 km E of Dalhousie Springs AD; *glabrous*). NULLARBOR:

B.C. Crisp 96, 28.v.1974, Lake Tallacootra (AD; fruiting). GAIRDNER-TORRENS BASIN (24 specimens): *Anon. (S. Aust. Pastoral Board) s.n.*, 23.x.1958, Wilgena (AD 97636211; *glabrous*); *Lay 155*, 20.xi.1970, c. 5 km W of Mullina Well, Wilgena Station (AD; *hairy*). FLINDERS RANGES (46 specimens): *Telfer 107*, 5.xi.1968, Hawker, Windy Hill (AD; *glabrous*); *Whibley 2196*, 26.x.1967, c. 6 km W of Balcanoona-Wertaloona turnoff, on road to Copley (AD & 3 dupl.; *hairy*). EASTERN (24 specimens): *Pfeiffer 2*, 2.i.1964, c. 6-8 km SW of Paratoo Homestead (AD; *glabrous*; habit like "a mulga"); *Pfeiffer 3*, 2.i.1967, same location (AD, 2 sheets; *glabrous*; "small trees 8-10 ft high decidedly droopy appearance...*H. leucoptera* without weeping appearance grows not far from coppice of this specimen"; habit photo); *Pfeiffer 9*, 20.xii.1967, on "Methuen" c. 16 km SW of Paratoo homestead (AD; *glabrous*; "small tree 8-10 ft high decidedly droopy appearance"). EYRE PENINSULA (23 specimens): *R. Brown* 1802 (syntype of *H. leucoptera*; fruits only); *Eardley s.n.*, 30.x.1942, Yudnapinna Station (AD 97617536 ex ADW; *glabrous*). NORTHERN LOFTY (8 specimens): *Copley 2920*, 30.xi.1969, c. ½km S of Telowie School (AD; *sparsely hairy*); *Higginson per Beauglehole 7359*, c. 1950, Port Germein (AD; *glabrous*); *Spooner 5280*, 24.vii.1977, South Hummocks Range (AD; fruits only); *Boehm 413*, 9.xi.1963, c. 4 km W of Bower (AD; *hairy*). MURRAY (34 specimens): *McAlister 134*, 25.xi.1980, Danggali Conservation Park, 4 km E of Terawi turnoff (AD; *glabrous*). YORKE PENINSULA (2 specimens): *Smith 2384*, 2.i.1976, near Maitland (AD; *sparsely hairy*).

WESTERN AUSTRALIA. WITHOUT SPECIFIC LOCALITY: *Drummond 14*; (types of *H. kippistiana* Meissner; *sparsely hairy*).

NORTHERN TERRITORY. CENTRAL AUSTRALIA NORTH (2 specimens): *Lazarides 6007*, 16.ix.1956, 37 miles SE of Yuendumu Native Settlement (AD, MEL; *hairy*; habit photo). CENTRAL AUSTRALIA SOUTH (23 specimens): *Barker 3515 & Ulyatt*, 14.ix.1978, c. 1 km by road NNW of crossing of 16 Mile Creek by Stuart Highway, c. 28 km NNW of Alice Springs (AD, IBSC, KRAM, G; fruits); *Ulyatt 109-111*, 8.xii.1978, same locality (AD; *glabrous*; material from different trees).

QUEENSLAND. GREGORY SOUTH: *Gardiner s.n.*, 16.viii.1962, c. 95 km S of Nappa Merrie Homestead (AD; fruits).

NEW SOUTH WALES. NORTH FAR WESTERN PLAINS (6 specimens): *Campbell 1261 & Pickard*, xi.1970, 3.2 km N of Turleys gate, S.A.-N.S.W. border (AD; *hairy*); *E. Ashby s.n.*, s.dat., Broken Hill (AD 966041248; *glabrous*). SOUTH FAR WESTERN PLAINS: *Corrick 7401*, 1.ix.1981, Gol Gol Forest, between Sturt Highway and Murray River (AD, MEL; fruits only).

VICTORIA. NORTHERN PLAINS (9 specimens): *Henshall 8/66/4*, 17.xii.1966, 3 miles N of Red Cliffs (MEL; *glabrous*); *St John s.n.*, xii.1907, Nhill (MEL s.n.; *glabrous*). MALLEE (8 specimens): *Chandler per Beauglehole 7774*, 7.xii.1949, Carwarp (MEL; *glabrous*); *Cummings 172, Crisp & Barnsley*, 9.x.1977, SW of Mildura, S shore of Rocket Lake (MEL; *sparsely hairy*); *Luly 216 (ANU 30178)*, xi.1980, shoreline away from Rocket Lake (MEL; *sparsely hairy*).

H. tephrosperma R. Br., Suppl. Primum Prod. Fl. Nov. Holl. Prot. Nov. (1830) 26.

Type citation: "Ora orient., mont. Port Jackson, 1817. *D. Cunningh.*" *Possible holotype*: BM.

H. vittata auct. non R. Br.: J.H. Willis, Hdbk Pl. Vict. 2 (1973) 50, p.p. (excluding S.Aust. occurrences and var. *glabriflora*).

H. tephrosperma R. Br. is newly recorded for South Australia, where it occurs in the Murray Valley region near the State's eastern border, with a single occurrence further west near Blanchetown. It resembles *H. leucoptera* in general appearance and fruit such that South Australian material has been previously misidentified as that species, but it differs in the often hooked apices of the leaves, the appressed rusty indumentum on the shorter rachis, and the flowers fewer in the inflorescence and with a shorter perianth tube. Of these characters, only the difference in rachis indumentum is constant. The presence of an apical pair of horns on the fruits and the reflexion of the leaf apices are not always evident in *H. tephrosperma* and also occur in *H. leucoptera*, although much less frequently. Variation in seed colour in each species, like the floral characters, also overlaps.

The rachis indumentum is often apparent in non-flowering material of each species and use of this character has shown that much material of *H. tephrosperma* has been misidentified in the past, not only as *H. vittata* (see below), but also as *H. leucoptera*. In particular *H. tephrosperma* is the source of confusion between *H. vittata* and *H. leucoptera* in north-western Victoria (Galbraith 1950; Willis 1973, as var. *vittata*). A tree habit and

uncinate leaves were attributed to Victorian *H. vittata*, characters descriptive of *H. tephrosperma* but not present in typical *H. vittata*, a small shrub with straight leaves confined to southern South Australia. Previous misapplication of *H. vittata* to *H. tephrosperma* in New South Wales (e.g. Dixon 1906; Anderson 1947, rectified in Jacobs & Pickard 1981, Cunningham et al. 1981) had been brought to light by L.A.S. Johnson some years ago (D.J. McGillivray, pers.comm. 1984). Recently, *H. tephrosperma* been recorded for Victoria in Beauglehole (1979, 1980), Costermans (1981) and Jacobs & Pickard (1981) as a result of McGillivray's communications.

Specimens examined

H. tephrosperma R. Br.

(Representative outside South Australia).

SOUTH AUSTRALIA. MURRAY: *Cleland s.n.*, 12.x.1963, Renmark (AD 96410061); *Conrick 610*, s.dat., Danggali Conservation Park on Canopus-Morgan Vale Road (AD); *Foreman 40*, 25.iii.1978, Canopus Station (AD); *Kraehenbuehl 3383*, 4.ix.1974, Blanchetown-Waikerie road, 19 km NE of Blanchetown (AD); *Mack s.n.*, 21.ix.1969, East Sandy Dam, Morganvale Station (AD 96940152); *Sommen s.n.*, 30.ix.1973, between Canopus and Morganvale (AD 96318008, sic!).

NEW SOUTH WALES. CENTRAL WESTERN SLOPES (2 specimens): *Ising 2142*, 5.iv.1924, Logan Gate (AD). NORTH WESTERN PLAINS (2 specimens): *Cleland s.n.*, ix.1911, Cobar (AD 97732582). SOUTH WESTERN PLAINS: *Brazenor E4*, 1941, Moulamein (MEL); *Cleland s.n.*, 5.x.1912, Mirro[o] near Yanco (AD 97732583); *Hall s.n.*, 27.x.1969, CSIRO Field Station, 15 miles N of Deniliquin on Conargo Road (AD, MEL ex FRI 18511); *Willis s.n.*, 28.ix.1969, Cocopara Range, Mailman's Gap (MEL 503325); *Willis s.n.*, 30.ix.1969, Pulletop Nature Reserve, ca. 40 km NW of Griffith (MEL 503513). NORTH FAR WESTERN PLAINS: *Moore 6762*, 29.ix.1974, 62 km NW of Louth on road to Wanaaring via "Mt Mulyah" (AD); *Morris 612*, 30.vi.1921, near White Cliffs (AD).

VICTORIA. NORTHERN PLAINS (13 specimens): *Beauglehole 56169*, 4.v.1977, Lake Powell, ca. 16 km SE of Robinvale P.O. (MEL); *Falla 1*, early xi.1959, near Donald (MEL); *Falla 5*, s.dat., near Robinvale (MEL); *Muir 6130*, 2.x.1978, Goulburn Valley, 8 km WSW of Nathalia, beside Barmah-Shepparton road (MEL); *Watts 223*, iv.1917, Wycheproof (MEL). MALLEE (6 specimens): *Aston 110*, 1.xi.1958, Kulkyne State Forest, W of Lake Hattah (MEL); *Beauglehole 29330 & Finck*, 13.x.1968, N side of Wyperfeld National Park (MEL); *Begg s.n.*, 10.x.1963, c. 10 miles S of Swan Hill, along road between Croschen and Tresco West (MEL); *Muir 1132*, 13.viii.1980, beside Walpepup Lake, Timberoo Forest, in the Ouyen district (MEL).

H. vittata R. Br.

(Representative specimens)

SOUTH AUSTRALIA. EYRE PENINSULA: *Brown s.n.* (*Iter Austral. 3372*), 1802, Bay X [near Port Lincoln] (BM, sheets; K, 2 sheets; MEL 643225, MEL 643224; syntypes of *H. vittata* R.Br.); *Eichler 19505*, 13.x.1967, c. 45 km SE of Streaky Bay along Flinders Highway, c. 3½ km SE of the turnoff to Sceale Bay (AD). SOUTHERN LOFTY: *Eichler 14537*, 19.xi.1957, Cape Jervis (AD). KANGAROO ISLAND: *Cleland s.n.*, 18.xi.1924, Rocky River (AD 96807962). SOUTH EASTERN: *C.R. Alcock 3012*, 5.xi.1969, Big Heath National Park, north-west (Brown Stringy Bark) corner (AD); *Sharrad 359*, 3.xi.1959, c. 6 km W of Malinong, which is c. 45 km SE of Murray Bridge (AD); *West 2352*, 8.x.1977, 20 km NE of 'Emu Springs', on Box Flat-Coombe track, 5.3 km SE of Box Flat which is 34 km SSW of Lameroo (AD).

LOCALITY UNCERTAIN: *Anon. (Herb. Mueller) s.n.*, s.dat., Murray-scrub (MEL 642101, cited in Willis 1957).

H. sericea Schrader in Schrader & Wendl., Sert. Hannov. (1797 or ?1798) 27.

Type citation: None given apart from diagnosis, but possibly from Botany Bay. *Holotype*: ?GOET (n.v.)

H. vittata R. Br. var. *glabriflora* J. Black ex J.H. Willis, Victorian Nat. 73 (1957) 150.—*H. vittata* R.Br. var. *glabriflora* J. Black, Fl. S. Austral. (1948) 265, nom invalid. *Holotype*: *J.B.Cleland s.n.*, viii.1944, near Stirling E. school (AD 95643529, Herb. Black). *Isotype*: AD 96807226.

Since the late 1930s an unnamed taxon of needlewood was known to the botanists E.H. Ising, J.B. Cleland and J.M. Black from the Mt Lofty Ranges near Stirling East. Black (1948) distinguished it as a separate variety *glabriflora* of *H. vittata*, differing from the typical

variety in floral indumentum and larger fruit. Willis (1957; also 1973) validated the name by supplying the mandatory Latin description and citing a collection in the Black Herbarium (AD) as holotype; in so doing he also ascribed a specimen from western Victoria to the taxon.

L. Haegi (pers. comm. 1973) recognised that the specimens of *H. vittata* var. *glabriflora* in the Black Herbarium, including the holotype, belonged to the common south-east Australian species *H. sericea* Schrader, although he did not annotate specimens at the time.

The origin of *H. sericea* in the Mt Lofty Ranges is debatable. There is the possibility that populations surrounding Stirling East are natural occurrences, showing the not uncommon relictual pattern of disjunction between the Mt Lofty-Flinders range system of South Australia and the mountains and forest regions of the eastern States discussed by various authors (e.g. Parsons 1973; Specht 1972). However, in view of the relatively late discovery of *H. sericea* in the Mt Lofty Ranges in an area populated almost 100 years before, its restriction to such areas of early settlement, its use in cultivation in the State as early as 1925 (*Dutton AD 97850393*), and its noxious weedy properties in New Zealand (Sykes 1982) and South Africa (Morris 1982; Kluge & Richardson 1983) as well as its naturalisation in Portugal (Ball 1964), it seems more likely that all populations have originated through introduction.

The collection *MEL 643057*, which according to its label was collected by C. French jr. from the Wimmera region of Victoria and was attributed to *H. vittata* var. *glabrifolia* by Willis (1957, 1973), is in fact an eastern Victorian species, *H. lissosperma* R.Br. It emanated from the herbarium of C. Walter, whose collections are notorious for their erroneous localities (McGillivray 1973; Mrs M. Corrick & Mr R.V. Smith, pers. comm. 1983).

Specimens examined

H. sericea Schrader

SOUTH AUSTRALIA. SOUTHERN LOFTY (arranged chronologically): *Ising s.n.*, 13.iii.1937, Mt Lofty near Stirling East Public School, opposite Mr Daw's (AD 966081087; "?Garden escape. Mr Daw has known of this species growing there for 10 to 15 years...He says it also grows on hillside on East of Miss Snow's. Saw 15-20 plants"); *Ising s.n.*, 18.vi.1938, prior locality (AD 97701240); *Cleland s.n.*, 6.iv.1944, Colony (12 counted) in scrub at Stirling East, Mt Lofty (AD 96807224, "Not ornamental so unlikely to be a garden escape"; AD 96807225 "near school" (AD 9752529, Herb. Black); *Cleland* viii.1944, near Stirling East school, "about 12 plants" (holotype of *H. vittata* var. *glabriflora* J.Black ex J.H.Willis); *Wade s.n.*, 26.ix.1944, Stirling East (AD 97650206); *Wade per Cleland s.n.*, 12.viii.1947, Stirling (AD 966130091); *Ising s.n.*, 20.i.1953, Stirling East (AD 96617007; "From same locality, only place known where var. [*H. vittata* var. *glabriflora*] occurs"); *Ising s.n.*, 7.xi.1953, Stirling East (AD 96617006); *Ross s.n.*, viii.1956, Piccadilly Valley (AD 95927091; "On side of road, growing wild"); *Ising s.n.*, 30.iii.1957, Stirling East (AD 96625031; "From the type locality of the variety and the only locality known—and only a few plants now growing"); *Ising s.n.*, 7.viii.1957, Stirling East (AD 96149275; "Type locality"); *Eichler 13906*, 17.viii.1957, Stirling East, near the school (AD; "in natural scrub"); *Lange s.n.*, 12.vii.1961, a few miles N of Stirling, down slope from road junction signposted "Woodhouse Golf Links" (AD 96727001; "Tall shrub c. 3 m, in dense understorey near drainage line under *Eucalyptus rubida E. viminalis*"); *Whibley 821*, 23.vii.1961, Stirling East, on property of D.J.E. Whibley (AD); *Ising s.n.*, 13.iv.1965, Stirling East (AD 96848245); *Whibley 3893*, 2.viii.1973, Property of D.J.E. Whibley at Stirling East (AD; "Not an escape from adjacent planting; occurring in roadside remnant of *Eucalyptus obliqua* sclerophyll forest. A few shrubs 4 m high" pers. comm. 1983); *Barker 1894*, 29.v.1977, Watiparinga National Trust Reserve, Belair (AD; "Cultivated (partly), partly escaped. Area once cleared, replanted in 1957 with Australian trees and shrubs. Shrubs to c. 1m, common in area, probably at least some spreading from originally planted one with possible assistance of fires"). CULTIVATED: *Dutton s.n.*, ix.1925, Anlaby (Northern Lofty region) (AD 97850393; Also a series of collections from Wittunga Botanic Garden dating from 1968.

NEW SOUTH WALES (representative only). CENTRAL COAST: *Ising s.n.*, 17.vi.1961, Beecroft, an outer north-western suburb of Sydney (AD 96220026); *Ising s.n.*, 13.ix.1969, North Turramurra, suburb of Sydney (AD 97023022). SOUTH WESTERN SLOPES: *Evans 2640*, 7.x.1967, Mt Jerrabomberra, 2 miles SW of Queanbeyan (AD).

VICTORIA. WESTERN HIGHLANDS (representative only): *Beauglehole 30817*, 22.vi.1969, Grampians, Black Range, extreme N end, E side of Picnic Rocks (AD); *Haegi 643*, 18.iv.1975, Victoria Range, Grampians, Halls Gap

to Mt Zero Road, c. 26 km SE of Mt Zero (AD); *Haegi 1453*, 25.ix.1977, Grampians, c. 0.5 km NW of Gotton Gorge turnoff on Halls Gap-Mt Zero road (AD).

NEW ZEALAND. NORTH ISLAND: *Goulding 888*, 6.viii.1977, Waitemata County, East Coast Bays Road, S of Lonely Track Road (AD); *Halliday 85*, 19.vii.1974, Auckland University Reserve, Swanson, at end of Tram Valley Road, near Swanson Stream (AD).

H. lissosperma R. Br.

(Representative only).

VICTORIA. EASTERN HIGHLANDS: [?*Soues*] *per St John*, 19.xii.1907, Buffalo Mountains (MEL 536988); *Willis s.n.*, 6.xii.1970, Logging road ca. 6 km NNE of Snowy Plains air-strip, Wonnongatta-Macalister River Divide (MEL 502508, AD 97612365).

TASMANIA. EAST COAST: *Orchard 5271*, 20.i.1981, One O'Clock Hill, above Murderers Marsh, Mt Dromedary (AD). MT FIELD: *Cleland s.n.*, 24.x.1939, road to Lake Fenton (AD 97308414). MT WELLINGTON: *Ising s.n.*, 14.i.1928, The Springs (AD 97648212).

SPECIMEN WITH DISCORDANT LABEL: *C. French jr. s.n.*, x.1898, Mallee, Victoria, "probably near Pine Plains Station" (in hand of J.H. Willis, MEL 643057).

H. vittata R.Br.

(See under *H. tephrosperma*).

Acknowledgments

I am grateful for the assistance of Dr L. Haegi and Dr J.P. Jessop for comments on the manuscript, Mr B.R. Maslin for information on Cunningham's collecting localities, and to others whose personal communications are cited in the text.

References

Anderson, R.H. (1947). "The Trees of New South Wales," 2nd edn. (Govt Printer: Sydney).

Bailey, F.M. (1901). *Hakea*, Schrad. In "The Queensland Flora," pp. 1344-1351, pl. LIX. (Queensland Govt: Brisbane).

Ball, P.W. (1964). *Hakea* Schrader. In T.G. Tutin et al. (Eds). "Flora Europaea", Vol. 1, p. 69. (Cambridge Univ. Press).

Barker, W.R. (1984). Proteaceae. In J.P. Jessop (Ed.). "A List of the Vascular Plants of South Australia", 2nd edn, pp. 74-75. (Adelaide Botanic Gardens & State Herbarium and Environmental Survey Br., Dept of Environment & Planning).

Barker, W.R. (In press). Proteaceae. In J.P. Jessop & H.R. Toelken (Eds). "Flora of South Australia", Vol. 1. (Govt Printer: Adelaide).

Beadle, N.C.W. (1982). "Students Flora of North Eastern New South Wales", Part II. (Dept. Bot., Univ. New England: Armidale).

Beauglehole, A.C. (1979). "The Distribution and Conservation of Native Plants in the Victorian Mallee". (Western Victorian Field Nat. Clubs Assoc.: Portland).

Beauglehole, A.C. (1980). "Victorian Vascular Plant Checklists 13-Study Area and 24-Grid Distribution". (Western Victorian Field Nat. Clubs Assoc.: Portland).

Black, J.M. (1924). *Hakea*, Schrad. In "Flora of South Australia", pp. 159-161. (Govt Printer: Adelaide).

Black, J.M. (1948). *Hakea*, Schrad. In "Flora of South Australia" 2nd edn, pp. 264-267. (Govt Printer: Adelaide).

Blake, S.T. (1963). New or noteworthy plants chiefly from Queensland, II. *Proc. R. Soc. Qld* 73, 61-77, pl. VI-VII.

Boomsma, C.D. (1972). Native trees of South Australia. *Woods & Forests Dept., S. Austral. Bull.* 19.

Boomsma, C.D. (1981). Native trees of South Australia. *Woods & Forests Dept., S. Austral. Bull.* 19, 2nd edn.

Brown, R. (1830). "Supplementum Primum Prodromi Florae Novae Hollandiae: exhibens Proteaceas novas . . ." (London).

Costermans, L.F. (1981). "Native Trees and Shrubs of South-eastern Australia". (Rigby: Adelaide).

Cunningham, G.M., Mulham, W.E., Milthorpe, P.L. & Leigh, J.H. (1981). Proteaceae. In "Plants of Western New South Wales", pp. 211-218. (N.S.Wales Govt Printing Office).

Dixon, W.A. (1906). "The Plants of New South Wales". (Angus & Robertson: Sydney).

Eichler, Hj. (1964). "Bibliographic Catalogue of Vascular Plants of South Australia". (Manuscript held at AD, the Proteaceae Section probably compiled prior to 1962).

Eichler, Hj. (1965). "Supplement to J.M. Black's Flora of South Australia". (Govt Printer: Adelaide).

Galbraith, J. (1950). *Hakea vittata*, "Black" and "White". *Vict.* Naturalist 66, 179.

George, A.S. (1981). Proteaceae. In J.P. Jessop et al. (Eds). "Flora of Central Australia", pp. 18-24. (Reed: Sydney).

Jacobs, S.W.L. & Pickard, J. (1981). "Plants of New South Wales". (Govt Printer: New South Wales).

Johnson, L.A.S. (1962). Taxonomic notes on Australian plants. *Contrib. N.S. Wales Nat. Herb.* 3, 93-102.

Kluge, R.L. & Richardson, D.M. (1983). Progress in the fight against *Hakea*. *Veld & Flora* 69, 136-138.

McGillivray, D.J. (1973). Michel Gandoger's names of Australian plants. *Contrib. N. S. Wales Nat. Herb.* 4, 319-365.

McGillivray, D.J. (1975). Australian Proteaceae: new taxa and notes. *Telopea* 1, 19-32, pl. I-V.

Morris, M.J. (1982). Biological control of *Hakea* by fungus. *Veld & Flora* 68, 51-52.

Parsons, R.F. (1973). Disjunctions in the distribution of *Eucalyptus* species between western Victoria and the Mount Lofty Ranges-Flinders Ranges area, South Australia. *Proc. R. Soc. Vict.* 86, 29-34.

Specht, R.L. (1972). "The Vegetation of South Australia". (Govt Printer: Adelaide).

Sykes, W.R. (1982). Checklist of dicotyledons naturalised in New Zealand 12. Haloragales, Myrtales, Proteales, Theales, Violales (excluding Violaceae). *N. Zeal. J. Bot.* 20, 73-80.

Willis J.H. (1957). Vascular flora of Victoria and South Australia. (Sundry new species, varieties, combinations, records and synonymies). *Vict. Naturalist* 73, 149-160.

Willis, J.H. (1973). "A Handbook to Plants in Victoria, Vol. II. Dicotyledons". (Melbourne Univ. Press: Carlton).

J. Adelaide Bot. Gard. 7(3): 249-271 (1985)

TAXONOMY OF THE SOUTH AUSTRALIAN SPECIES ALLIED TO *HAKEA ULICINA* R. BR. (PROTEACEAE)

L. Haegi & W.R. Barker

Adelaide Botanic Gardens and State Herbarium,
North Terrace, Adelaide, South Australia 5000.

Abstract

Taking into account the recent publication of the new species *H. repullulans* H.M. Lee from western Victoria and South Australia, it is shown that the name *H. ulicina*, widely used in the past, does not apply to South Australian *Hakea*. The name *H. carinata* F. Muell. ex Meissner is re-instated for a species endemic to the Flinders and Mt Lofty Ranges and the South Eastern region. *H. muelleriana* J. Black is confirmed as a distinct species, occurring in drier regions from Eyre Peninsula to the South Eastern region and extending to Kangaroo Island and Victoria. The occurrence of exceptionally broad-leaved forms of this species on Kangaroo Island warrants further biological and taxonomic investigation. *H. aenigma* W.R. Barker & Haegi, a Kangaroo Island endemic apparently most closely related to *H. repullulans*, is described. This new species is unusual in its sterility, apparent genetic uniformity and complete dependence on suckering as a means of reproduction.

Introduction

In the absence of any comprehensive treatment of *Hakea* since that of Bentham (1870) taxonomic concepts within the genus have developed largely in regional floras. Included among the species of *Hakea* treated in the most recent flora account for South Australia (Black 1948) were *H. muelleriana* J. Black and *H. ulicina* R. Br., including its variety var. *latifolia* J. Black. In a supplement to Black's Flora, Eichler (1965) expressed doubt about the rank of *H. muelleriana*, suggesting it might better be treated at the infraspecific level, as "*H. ulicina* var. *flexilis* FvM. ex Black." Several years later Willis (1973) retained *H. muelleriana* without comment in his handbook on the Victorian flora but stated that recognition of var. *latifolia* within *H. ulicina* hardly seemed warranted. In an account of the native shrubs and trees of south-eastern Australia, however, Costermans (1981) applied Black's (1948) treatment, though without reference to the statements of either Eichler (1965) or Willis (1973).

Material of a Kangaroo Island *Hakea* first collected in 1924 by J. B. Cleland was initially regarded as close to *H. multilineata* (Cleland & Black 1927) and included in that species by Black (1948). Eichler (1965) found that all South Australian material previously assigned to *H. multilineata* was to be known as *H. francisiana*, and in an account of this group of species, Maconochie (1973) indicated that the Kangaroo Island *Hakea* known only from a small number of mostly sterile specimens, had close affinities with the latter. More recently, one of us (W.R.B.) recognised the affinity of this material with *H. ulicina*. The same conclusion was evidently drawn independently by Cleland (1967) who included "*H. ulicina* and var. nov." on a cyclostyled list of Kangaroo Island plants.

Against the background presented above a *Hakea ulicina* complex can be recognised. The existence of such a complex, requiring taxonomic clarification, has been evident from the uncertainty in application of names in the collections of the State Herbarium of South Australia. In particular, the apparently continuous gradation from very narrow, terete or triquetrous leaves c. 1 mm broad to linear-obovate leaves over a centimetre broad seems to have provided a significant impediment to distinguishing the described taxa.

On the basis of the study of these specimens and the collections of the National Herbarium of Victoria, combined with anatomical studies and fieldwork on mainland South Australia and Kangaroo Island, a revised classification is proposed. Names are applied

following examination of relevant type material from the above and other herbaria. In South Australia, the endemic species *H. carinata* F. Muell. ex Meissner is re-instated for plants from the Flinders and Mt Lofty Ranges, and the South-Eastern region. *H. muelleriana* J. Black is confirmed as a distinct species, occurring in drier regions including Eyre Peninsula, Yorke Peninsula, Murray and South-Eastern regions, Kangaroo Island and extending to western Victoria. *H. aenigma* W.R. Barker & Haegi, endemic to Kangaroo Island, is newly described.

This study began in the form of an Honours Degree research project and the resulting thesis is referred to where aspects have been considered in more detail than can be reported here. During the extended course of the study another detailed investigation of *H. ulicina*, centred on Victorian populations, has led to the segregation of the new, very closely related species *H. repullulans* (Lee 1984). This species, which is taxonomically equivalent to *H. ulicina* var. *latifolia,* completes the representation of the *H. ulicina* complex in South Australia. Its main occurrence is in the western half of Victoria. *H. ulicina* s.str. does not occur in South Australia, but is found in central and eastern Victoria and New South Wales and on the islands of Bass Strait. *H. repullulans* is distinguished from *H. ulicina* s.str. principally in being lignotuberous. Except where they differ in this character, the other species of the complex are distinguished from *H. ulicina* s.str. essentially in the same features as those by which they differ from *H. repullulans.*

References to the works of earlier authors are arranged within the treatment of each species in such a way that the history of taxonomic concepts including the misapplication of names is made clear.

Morphology

Several diagnostic features brought to light in this study were obscured in the past by confusing variation. These, together with important distinguishing characters, some of a subtle nature requiring explanation, are discussed here.

Habit

The presence in *H. repullulans* (Lee 1984) and *H. aenigma* of a lignotuber and horizontal root system producing adventitious aerial shoots distinguishes these species from *H. carinata* and, so far as is known, *H. muelleriana.* Plants of the first two species resprout after fire while plants of the last two are killed by fire, regenerating only from seed (*H. carinata*: *Haegi 2703*). Some forms on Kangaroo Island assigned for the time being to *H. muelleriana* need to be investigated further with respect to this characteristic. The horizontal root-system is especially well developed in the sterile *H. aenigma*, in which new plants are established entirely from adventitious shoots arising from these roots. Leafy aerial shoots up to 50 cm tall arising at intervals of about 1 m along a horizontal root 2 cm in diameter and 4 to 5 cm under the soil surface were observed in one population (*Haegi 2287*). The stems of these shoots, 0.5 cm in diameter, were thickened to 2 cm in diameter below the soil surface and the root was swollen to c. 3 cm at the point of attachment but no finer roots were present at this point (figs 9B, C).

Branching habit is variable in all species but some distinct trends are apparent. Plants of *H. aenigma*, *H. carinata* and *H. repullulans* are usually single-stemmed and sparingly branched or bear short lateral branches. This trend is best developed in *H. carinata* which is usually a narrowly erect, divaricately branched shrub of somewhat irregular proportions. Plants of *H. muelleriana* generally have a rounded shape, resulting from free development of lateral branches from the very base upwards. Single-stemmed, arborescent forms of *H. muelleriana* are found in dry forest associations at some sites on Kangaroo Island.

Indumentum

As in most species of *Hakea* (Bentham 1870), the new shoots of the species considered here are beset with a dense indumentum of closely appressed horizontal hairs attached by a short central stalk. These T-shaped hairs are generally rust-brown in colour and have been largely lost from the leaves by the end of the first season of growth. This applies to all species of the *H. ulicina* complex, which have essentially glabrous leaves in the mature state, though in *H. repullulans* and, to an even greater degree in *H. aenigma*, the indumentum tends to persist sparsely beyond the first season. The type and persistence of the hair covering of the branchlets is more useful diagnostically.

The branchlets of *H. muelleriana* are soon glabrescent, being glabrous (and deep reddish-brown) by the time of flowering. In the other species a more or less persistent indumentum occurs and the underlying surface of the branchlet is deep grey-brown. In *H. aenigma* this indumentum consists of rust-brown appressed T-shaped hairs with a few colourless ones, most of the coloured ones eventually losing their colour with age. This hair-covering always persists until and down to the point where flowering begins on the branchlet and may persist a further season or two until it is eventually replaced by grey, smooth bark. *H. carinata* is similar but its indumentum has a finer texture and is deciduous a little sooner.

In *H. repullulans* the branchlet indumentum is more variable but almost always persists well beyond flowering. Early glabrescence has been seen only on vigorous new adventitious shoots. Usually, the indumentum is quite distinctive and consists of densely arranged, porrect, colourless or stramineous hairs. These hairs are usually forked with one long erect arm and the other very short or absent. In some specimens however, the hairs may be mixed and of up to three types: appressed horizontal (few, probably remnants of initial indumentum on new shoot); forked with equal oblique arms; forked with one main erect arm. The first two types are apparently always rust-brown at first, losing their colour with age. Frequently the tomentose axes are black because of the presence of a black fungus. In all cases, *H. repullulans* is distinct from the other species because a substantial component of the indumentum consists of non-appressed hairs.

Leaves

Various characters of the leaves serve to distinguish the species of the complex though these have generally been poorly understood in the past. Lee (1984) has described the important features of the leaves of *H. ulicina* and *H. repullulans*. Probably the most distinctive and readily identifiable foliar character in the complex is the orientation of the lamina. In *H. repullulans* (and *H. ulicina*) the leaf is twisted through 90° at the base so that the lamina lies in a vertical plane. This readily distinguishes these species from the other South Australian species in which no twisting occurs and the lamina, though sometimes up- or down-curved, is horizontally oriented.

Leaf shape

Leaf shape and especially leaf width are extremely variable among the species of the complex. *H. aenigma* is perhaps most distinct, having considerably longer leaves than in the other species. Among the remaining species however, the high degree of variability in leaf shape has led to considerable confusion, especially in South Australia where the distributions of all three species overlap. In the past the narrowest-leaved plants were assigned to *H. muelleriana* (earlier as *H. ulicina* var. *flexilis*), the intermediate ones to *H. carinata* (as *H. ulicina* var. *carinata* or as *H. ulicina* and therefore not distinguished from Victorian *H. ulicina* s.str.) and the broadest ones to *H. ulicina* var. *latifolia* (now *H. repullulans*). Although this is in agreement with general trends, study of the patterns of variation in other characters

(including some of the leaf) indicate that leaf shape is unreliable as a diagnostic feature. In fact, it is variable within each species and highly so within *H. carinata* and *H. muelleriana.*

As a species, *H. carinata* is characterised by a high degree of within-population variation in leaf width. Some populations are less variable than others but among most of the 49 to which the specimens can be assigned, broad and narrow-leaved plants occur together and the leaves of the broader-leaved plants are usually at least twice or three times as broad as those of the narrower-leaved plants. In some populations they are up to five times as broad.

Superimposed on this within-population variability is a pattern of variation correlated with geographical occurrence. Broad-leaved plants are more common in the south-eastern part of the distribution and the broadest-leaved plants occur there. It is only in this area, from the south-eastern margin of the Mt Lofty Ranges to the southern limit of the species, in the upper South-Eastern Region, that plants with leaves over 8.5 mm (and up to 12.5 mm) broad occur. Throughout the remainder of the distribution, the usual range of leaf breadth is 1-6 mm and leaves up to 8.5 mm are uncommon. This pattern is illustrated in the distribution map of *H. carinata* (fig. 11) which distinguishes populations with plants having leaves more than 8.5 mm broad.

With few exceptions, very broad-leaved plants occur throughout the south-eastern populations, though at least some of them are also highly variable [e.g. at Padthaway: narrow-leaved 2 mm (*Canty AD 98146347*; broad-leaved 9 mm (*Fatchen et al. AD 97641206*)]. Plants with leaves over 8.5 mm broad are absent from the collections of only three populations. In one of these (6km E of Woods Well) only three plants were seen (*Haegi 532*) and the specimens have broad leaves mostly in the range 6-8.5 mm. The second population is represented by a single specimen (*J.R. s.n. AD 97107226*) collected from the 'Archibald and Makin Wild Life Reserve', a very general locality description. Further collections from this area could well bring to light broader-leaved plants.

Leaf length is also very variable in *H. carinata* but this variation is correlated neither with that of leaf breadth nor geographical occurrence.

Throughout most of its range, *H. muelleriana* exhibits much less variation in leaf shape than *H. carinata.* On the mainland, where the greater part of its distribution occurs, *H. muelleriana* has subterete or trigonous leaves. The leaves usually dry with a shallow groove

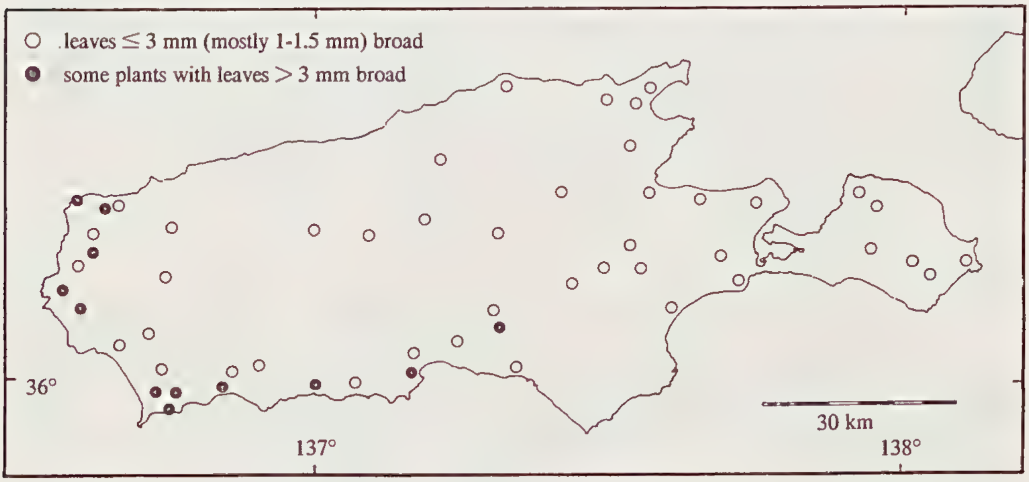


Fig. 1. Distribution of narrow-leaved and broad-leaved populations of *H. muelleriana* on Kangaroo Island, South Australia.

on the upper side (though this may not be conspicuous in the fresh state) and in transverse section are deeper than wide. This shape, an inverted isosceles triangle with two long sides, becomes more pronounced in more northern populations, especially those from northern Eyre Peninsula.

On Kangaroo Island *H. muelleriana* exhibits a much wider range of variability in leaf-shape, although subterete leaves are largely absent. Over much of the island plants with deeply trigonous leaves 1 to 1.5 mm broad and 1.5 to 2 mm deep, as sometimes seen on the mainland, occur in more or less uniform populations. However, near the southern coast in the western half and near the western coast, plants with broader more or less flat leaves mostly 3 to 6 mm broad are found (fig. 1). The broadest leaves found on mature plants, located in the far south-west near Remarkable Rocks, are up to 10 mm broad.

Populations in which broad-leaved plants occur are always variable in leaf width and in many cases individual plants are heteromorphic. This condition is characteristic of some species of *Hakea* (e.g. *H. trifurcata* (Smith)R.Br.). In *H. muelleriana* it arises because the first leaves on a new shoot are exceptionally broad while subsequent leaves exhibit a marked acrotonic decrease in breadth and are deeply trigonous in shape (fig. 2). In many cases, individual leaves are deeply trigonous at the base, passing rapidly into a broad, concave to flat form in the distal part.

Although the occurrence of broad leaves is restricted geographically in *H. muelleriana*, to date no evidence has been found of correlation with other characters. Despite the marked differences of the extreme forms, the observations on the pattern of variation do not support recognition of distinct taxonomic entities at any level. Investigations into biological aspects of the variation, particularly in relation to regeneration after fire, are continuing.

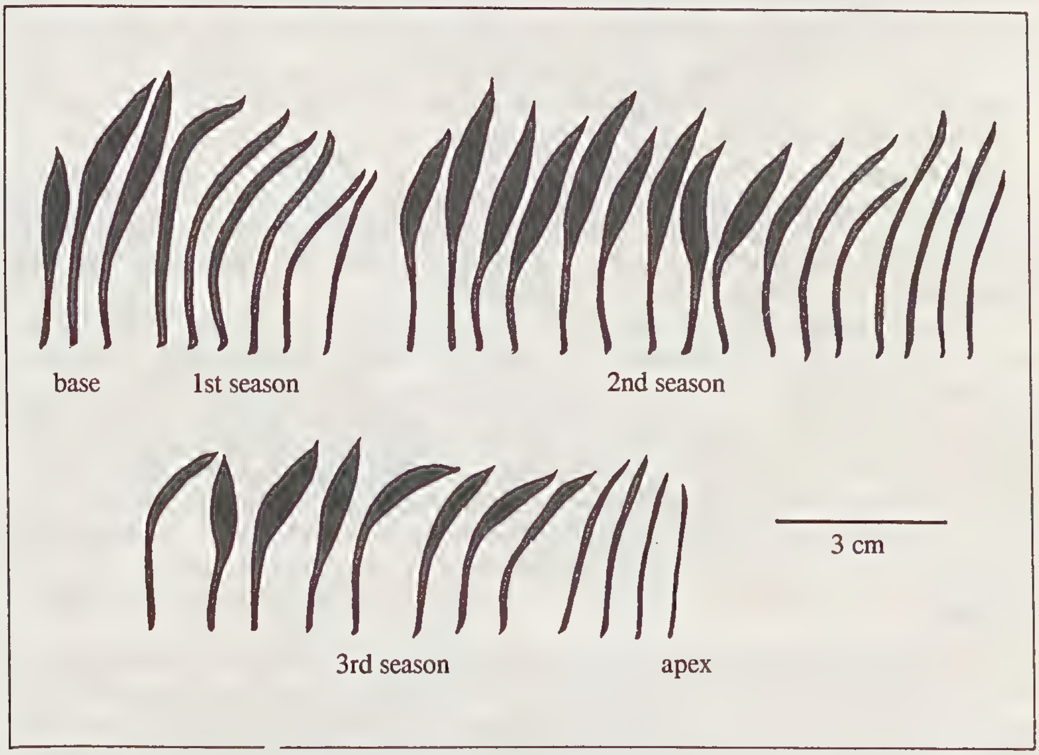


Fig. 2. Heteromorphic foliage in *H. muelleriana*: silhouettes of leaves from a single axis showing acrotonic decrease in leaf-width within each of three successive seasons' growth (*Haegi 341*).

Vein Prominence and its Anatomical Basis

The absence of conspicuous venation on the upper surface of the leaf was a distinguishing feature noted by Meissner (1856) in the original description of *H. carinata*; *H. ulicina* had been described as having one to three longitudinal veins prominent on both sides. In general, these observations still apply to the more broadly circumscribed *H. carinata* and to *H. repullulans*, a close relative of *H. ulicina*.

Usually only the veins along each margin and the midvein on the underside are prominent in *H. carinata*. The upper surface of the leaf is smooth. In some broad-leaved forms, two or rarely more additional longitudinal veins may be prominent on the underside. The veins of the lamina are only rarely visible on the upper surface in fresh material, but usually become faintly visible in dried material of broad-leaved plants.

The conspicuous, prominent longitudinal venation on both sides of the leaf in *H. aenigma* and *H. repullulans* usually distinguishes these species readily from broad-leaved forms of both *H. carinata* and *H. muelleriana*. In *H. aenigma* a greater number of veins (six to nine) is conspicuous on the underside of the leaf and these are usually more prominent than the one to four veins seen on the upper surface. The usually greater number of prominent veins and their closer spacing distinguishes *H. aenigma* from *H. repullulans*. In *H. repullulans*, five (or rarely three or seven) veins in addition to the marginal veins are usually equally conspicuous on both sides of the leaf.

The trigonous-leaved forms of *H. carinata* and *H. muelleriana* are similar in venation, with two marginal veins prominent together with the midvein on the underside. This venation is largely masked in subterete-leaved forms of *H. muelleriana* though it is somewhat more apparent in dried specimens, the leaves of which are often grooved above. The narrow-leaved forms of these two species can always be distinguished because of the proportionally greater breadth (compared with depth, in transverse section) in *H. carinata*. Broader-leaved forms are more difficult to distinguish because of similar shape and venation, though even in these forms of *H. muelleriana* usually only the midvein is prominent below. Only rarely are three to five veins prominent.

The anatomical basis of variation in vein prominence in the leaves has been studied. Details of the anatomy of the leaves of *H. repullulans* in transverse section are provided by Lee (1984) who refers also to the observations of Hamilton (1927) and Lamont (1976) on other species. Lee's observations are confirmed and the tissues described and their arrangement are very similar in the other species treated here.

For much of the bulk of the leaf, a layer of palisade mesophyll consisting of two rows of cells is found immediately underneath the epidermis. However, as reported by Lee (1984) and Lamont (1976) for the *H. sulcata* R.Br. group, large fibre bundles associated with the vascular strands disrupt the lateral continuity of the palisade mesophyll and it is at these points that the venation is prominent on the leaf surface. Where this disruption occurs, the fibre bundle and epidermis are always separated by a layer of thick-walled parenchyma cells. These are very similar to the polygonal starch-containing cells occupying the bulk of the centre of the leaf and staining with acidified phloroglucin indicates that both have lightly lignified cell walls. The cells of the subepidermal layer differ only in being more or less rectangular in transverse section. Lee (1984) has described this tissue as a *discontinuous hypodermis*.

The degree of prominence of the veins is dependent on the degree of disruption of the palisade mesophyll by the fibre bundles and hypodermis (fig. 3). In *H. repullulans* both the upper and lower bands of palisade mesophyll are substantially disrupted by the upper and lower bundles associated with the three or five main vascular bundles. Massive bundles associated with large vascular strands also disrupt the palisade mesophyll at the margins. This occurs also in *H. carinata*, but only the band of mesophyll along the underside of the leaf is

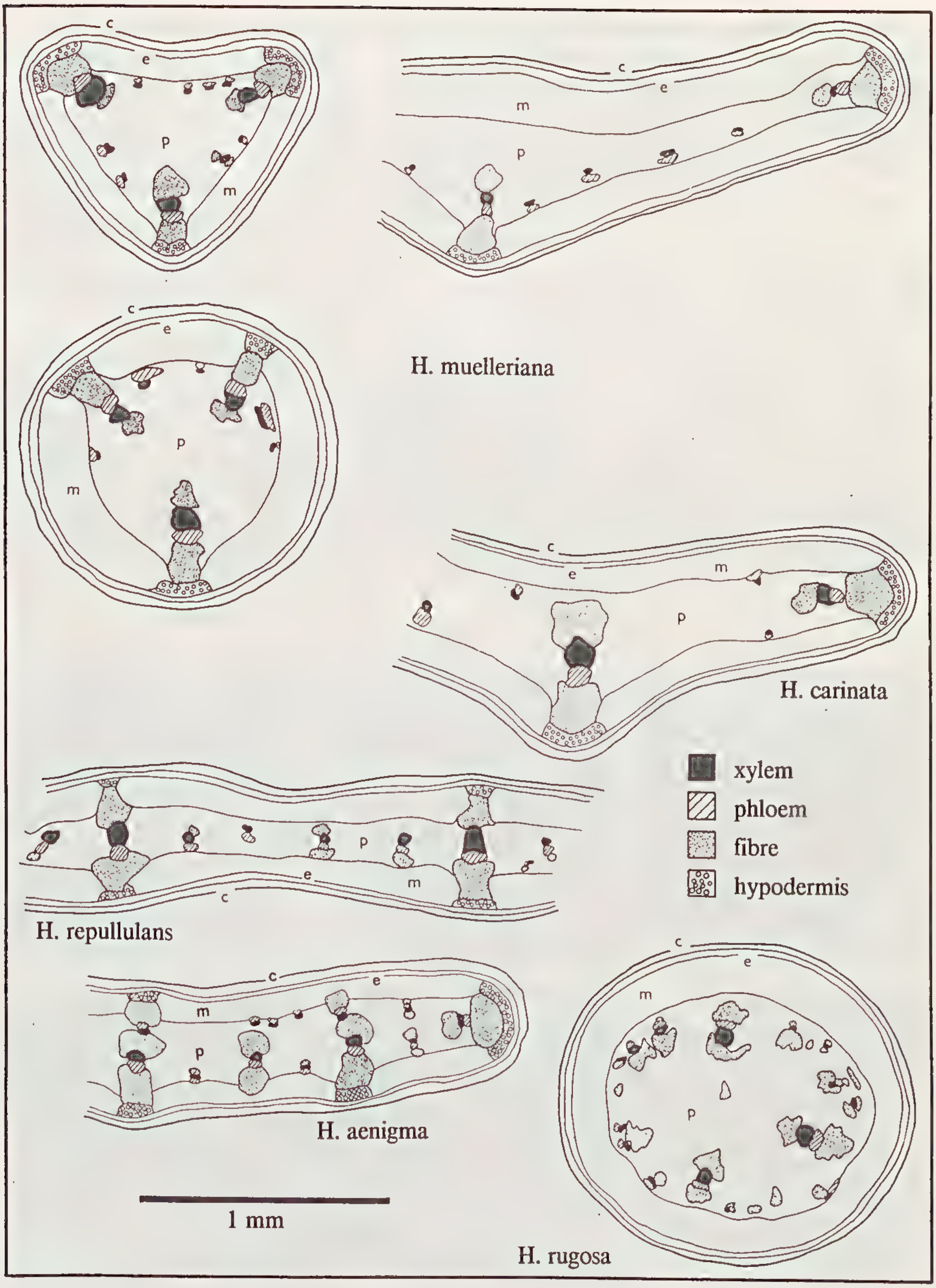


Fig. 3. Anatomical zone diagrams of transverse sections of leaves of *H. muelleriana* (*Haegi 341*, 3 sections), *H. carinata* (*Haegi 261*), *H. repullulans* (*Haegi 535*), *H. aenigma* (*Haegi 2288* and *Barker*) and, for comparison, *H. rugosa (Haegi 271*, 20.ii.1973, 5½ km S of Ashbourne on Goolwa road, AD), a terete-leaved species from Section *Hakea* lacking hypodermis; c, cuticle; e, epidermis; m, mesophyll; p, parenchyma.

disrupted. The mesophyll along the upper side is continuous, resulting in a smooth surface.

The very narrow-leaved forms of *H. carinata* have leaves more or less triangular in transverse section, with a major vascular bundle and associated fibre bundles at each apex (i.e. at each of the margins and at the midvein underneath). In broader-leaved forms additional vascular bundles between the midvein and margins become more strongly developed but are usually conspicuous only beneath because it is only here that the mesophyll is disrupted. On drying, these leaves may show some prominence of the veins on the upper side because of the proximity of the upper massive fibre bundles to the upper mesophyll. In contrast to most of the other tissues these heavily lignified fibres scarcely shrink on drying. Because the veins are considerably more prominent on the undersurface, even these broad leaves remain distinguishable from *H. repullulans* in which the prominence of the veins is more or less equal above and below.

The subterete-leaved forms of *H. muelleriana* are usually slightly angled, owing to the disruption of the mesophyll by the three main fibre bundles. This is in contrast to terete-leaved species from other sections of *Hakea* in which the vascular bundles and associated fibre bundles are found entirely within a continuous band of mesophyll (fig. 3; see also Hamilton 1927). The development of the fibre bundles in the subterete-leaved forms of *H. muelleriana* however is not as extensive as in other terete-leaved species of Section *Conogynoides* (e.g. Series *Teretifoliae* or the *H. sulcata* group) and the leaves are therefore not markedly striate or ribbed as in those species (see Lamont 1976). When more substantial development of the fibre-bundles does occur, trigonous leaves with prominent marginal veins and midvein prominent on the underside occur. These same three veins are prominent in the broad-leaved forms from Kangaroo Island. In general there is more development in broader leaves of the fibre bundles associated with vascular tissue and, as in *H. carinata*, a pair or two of veins additional to the midvein may, on rare occasions become prominent below. Some venation may become visible above in dried broad leaves.

H. aenigma has a distinctive leaf anatomy. It is similar to *H. repullulans* in having some veins prominent on both sides of the leaf. However, whereas the prominence of the veins on the upper and lower surfaces results from the development of the upper and lower fibre bundles associated with a single vascular strand in *H. repullulans*, it is attributable in *H. aenigma* to fibre bundles from two different vascular strands, one positioned above the other and separated by a fibre bundle. Among the species studied here, such paired strands have been observed only in *H. aenigma*. A similar arrangement was observed by Lamont (1976) for the two main vascular bundles in *H. gilbertii* Kipp. ex Meissner, a species of the *H. sulcata* group with ribbed terete leaves.

Pollen Morphology

Differences in gross morphology of the pollen grains provide useful diagnostic characters. Pollen from mature dehiscing anthers from one or two specimens of each species was studied using a scanning electron microscope. The resulting observations were confirmed by study of pollen stained with methyl green/phloxine or 0.1% cotton blue in lactophenol from several specimens of each species using a compound light microscope. Pollen grains of the different species differ in overall shape, sculpturing of the surface and degree of distinctness of the pore membrane (fig. 4). The pollen of *H. repullulans* is indistinguishable in external appearance from that of *H. ulicina* s.str., as observed also by Lee (1984). In this type, the sides of the triporate, triangular grain are convex and the almost smooth, very prominent pores are very distinct from the rugose exine of the body of the grain. The undersized, sterile and apparently empty pollen grain formed in *H. aenigma* (see Breeding System) are similar to the *H. ulicina* type but the texture of the sculpturing on the body is finer. A closer relationship of *H. aenigma* with *H. repullulans* and *H. ulicina* than with the other species is suggested by pollen morphology.

The pollen of *H. carinata* is similar to that of *H. ulicina* and *H. repullulans* in overall shape, including the very prominent pores, but the sides of the grain are straight rather than convex. The surface characteristics are quite different. In *H. carinata* there is a moderately dense covering of tubercles which extends onto the pore membrane. The grains therefore differ from those of the *H. ulicina* type also in the pores not being noticeably distinct from the body of the grain. The grains of *H. muelleriana* are similar to those of *H. carinata* in surface texture but the tubercles are more sparse.

Follicle

Characters of the follicle distinguish *H. carinata* from the other species of the complex (fig. 5). The distinguishing features are most readily observed in the median view of the follicle (i.e. viewing the suture rather than the dorsal side of one of the valves). In median view, the follicles of *H. carinata* are elliptic to ovate-elliptic with a gradually attenuated base and an acuminate apex tapering gradually into a slender beak. The beak is the persistent thickened base of the style and being fragile readily breaks off. In *H. muelleriana* and *H. repullulans* (and *H. ulicina*: cf. Lee 1984), the follicle in median view is ovate in outline, being proportionally broader and narrowed much less at the base than in *H. carinata*. The apex is not gradually tapered but has a lateral protuberance of varying prominence on each valve, which may be a vestige of the horn found near the apex on the valves of other species of *Hakea* (e.g. see Black 1948). The beak (1-2.5 mm in *H. repullulans* and 1-3.5 rarely

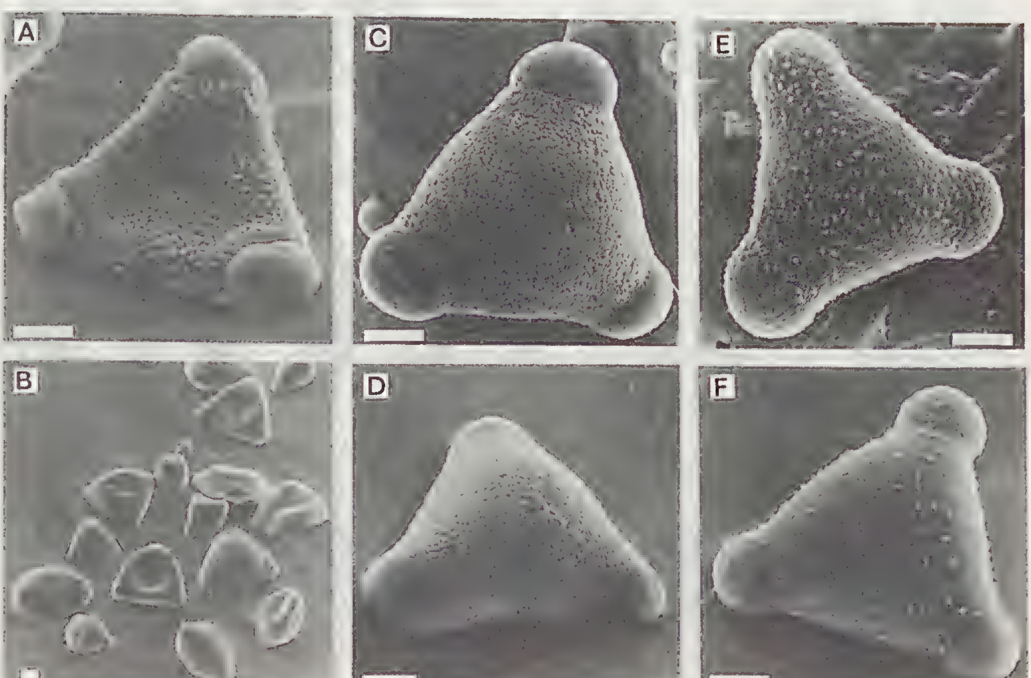


Fig. 4. Pollen morphology of species in the *H. ulicina* complex in southeastern Australia (scanning electron micrographs). A & B *H. aenigma* (pollen sterile, mostly collapsed: *Jackson 1212*); C, *H. repullulans* (*Muir 875*, 27.ix.1959, Mirranatwa Gap, Grampians, Victoria, MEL); D, *H. ulicina* (*Morrison*, s.n., 28.ix.1890, Frankston, Victoria, AD96412179); E, *H. carinata* (*Haegi 196*); F, *H. muelleriana* (*Wilson 1419*). Scales 10 μm.

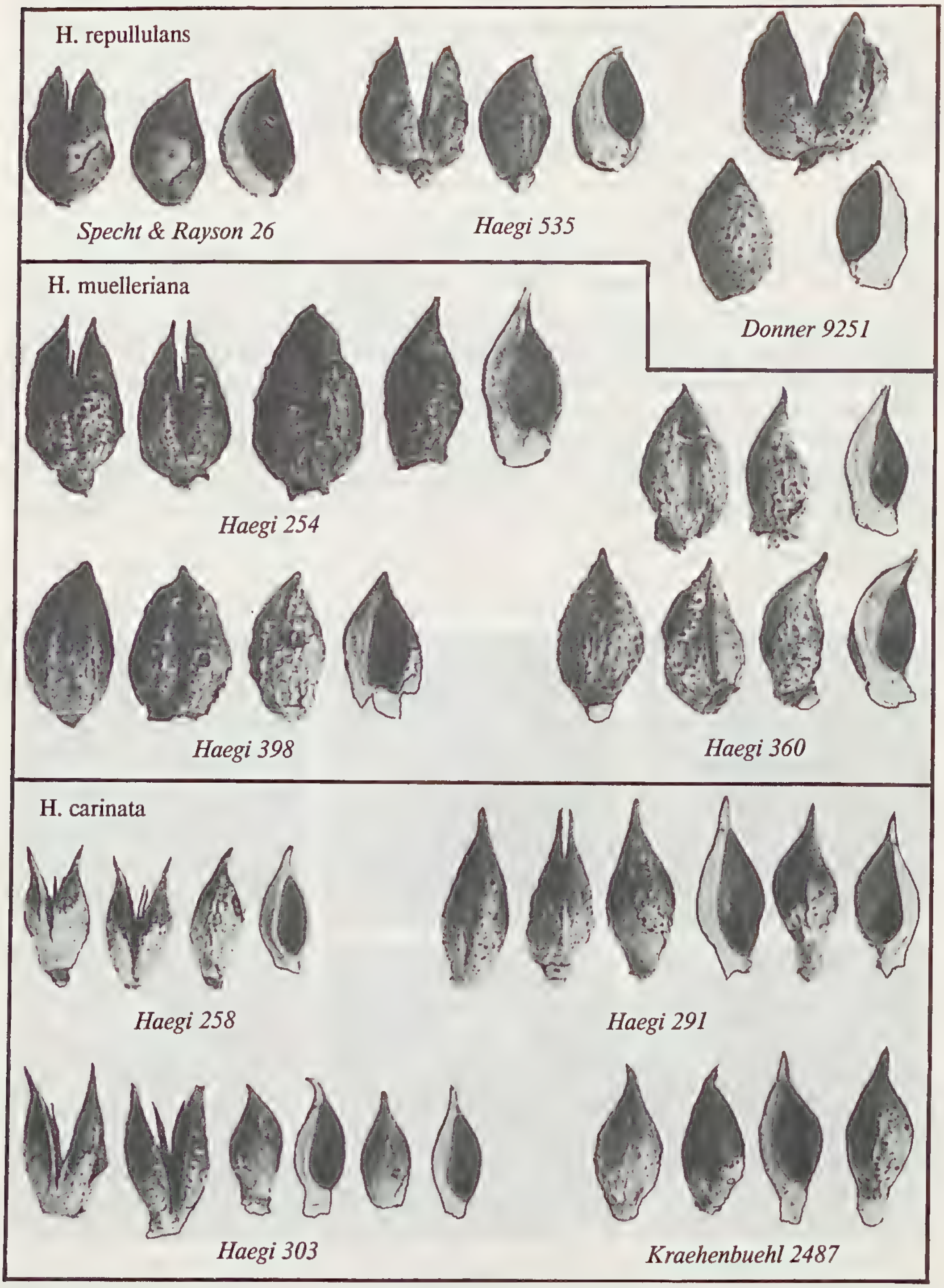


Fig. 5. Follicles (actual size) of the South Australian species allied to *H. ulicina*. Samples show median, lateral and inner views and are from single plants.

4 mm in *H. muelleriana*) is usually much shorter than in *H. carinata* (4-6.5 rarely only 3 mm) but care must be taken in using this as a distinguishing character because the beaks are frequently broken off. Fruit do not form in *H. aenigma*.

Seed

Useful diagnostic characters are found in the winged seeds (fig. 6). The seed-wings of *H. ulicina* and *H. repullulans* are indistinguishable and are uniformly blackish-brown, while those of *H. muelleriana* are pale grey-brown with blotches or streaks of darker pigmentation. The seed-wing in *H. carinata* is almost as dark as in *H. repullulans* but not quite as evenly pigmented; it is readily distinguished from *H. muelleriana*.

Two further features of the seed vary among the species. *H. carinata* has an almost globular to obovoid 'seed-body' (the solid part containing the embryo) with the testa extending as a ridge more than halfway towards the wing apex. This is readily seen in a longitudinal silhouette. The seed-body of *H. muelleriana* differs in being ellipsoid to ovoid-ellipsoid and the ridge extends scarcely more than a third of the way to the wing apex. It also begins higher up on the seed body than in *H. carinata*. In *H. repullulans* (and *H. ulicina*) the seed-body is usually larger than in the other species, and broadly elliptic in shape. The main ridge is very short or absent, being replaced by small narrow islands of hard tissue.

Breeding System

The species of the *H. ulicina* complex exhibit a variety of breeding systems which are usefully considered in relation to regeneration following fire. Where fruits are produced, these are woody and fire-resistant; they persist on the plant unopened, dehiscing to release the protected seed only following the death of the branch on which they are held.

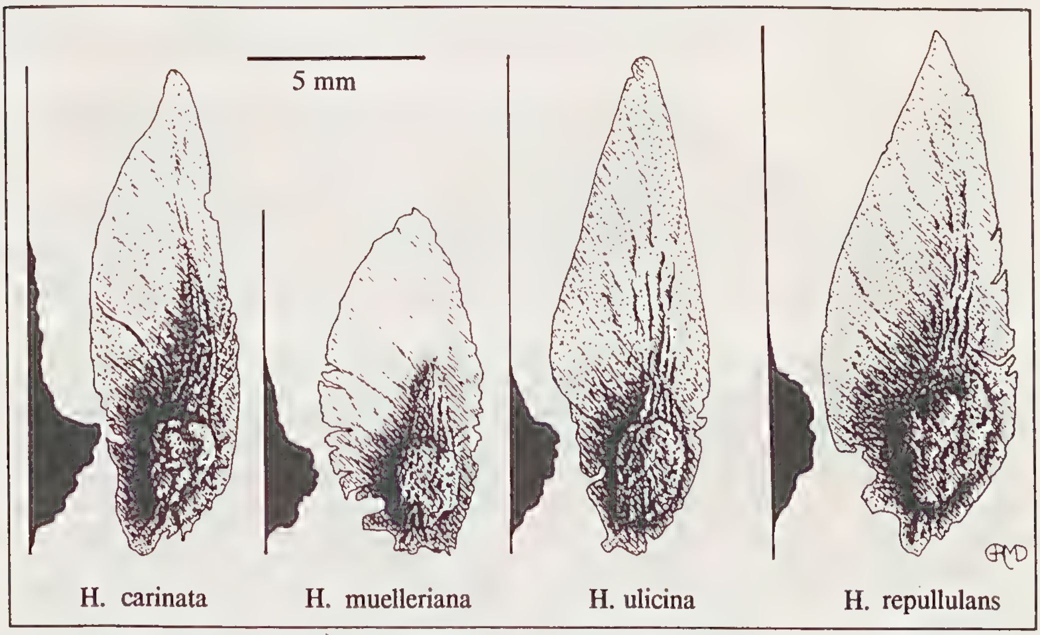


Fig. 6. Seeds of *H. carinata* (*Haegi 291*), *H. muelleriana* (*Haegi 274*), *H. ulicina* (*Czornij 473*, 9.xii.1971, Genoa Creek Track, c. 5 km W of Genoa, Gippsland, Victoria, AD) and *H. repullulans* (*Spooner 5380*) with longitudinal profiles showing shape of seed body and extent of ridge. Scale 5 mm.

At one extreme of the range of breeding systems is a strategy dependent entirely upon sexual reproduction involving bisexual entomophilous flowers. Fire kills such plants but promotes abundant seedling production, as in *H. ulicina* (Lee 1984) and *H. carinata*. At the other extreme is the complete dependence of *H. aenigma* on vegetative reproduction by means of horizontal subterranean roots from which suckers rise. A balance between these two reproductive strategies is found in *H. repullulans* which produces fruit but also regenerates from a lignotuber and horizontal roots (Lee 1984). The development of functionally male and female together with apparently bisexual plants in this species (Lee 1984) may function to maintain adequate variability within populations through outcrossing. This would compensate for the tendency for genetic uniformity through vegetative reproduction. Lee (1984) further observed that 'desert' or sand-heath populations of *H. repullulans* (based on material from Big Desert and Little Desert, Victoria) are consistently bisexual-flowered with all plants setting fruit. However, populations in South Australia which adjoin these same Victorian sand-heaths show highly malformed pollen (*Specht & Rayson 26*; *Symon 10781*).

Knowledge of the breeding system in *H. muelleriana* is far from complete. Judging from herbarium specimens and labels, most plants, particularly from mainland populations, produce abundant fruit and suckering has not been recorded, suggesting a strategy similar to that of *H. carinata*. However, as suggested above (see Leaf Shape) there is reason to investigate further the broad-leaved populations of *H. muelleriana* on Kangaroo Island. Pronounced differences in the abundance of fruit on different plants within populations has been observed but the reason for this is unknown.

Relationships

The *H. ulicina* complex in south-eastern Australia divides into two groups, the first comprising *H. ulicina*, *H. repullulans* and *H. aenigma*, the second *H. muelleriana* and *H. carinata*. Leaf venation characters, pollen morphology and indumentum persistence on the branches form the basis of this subdivision. *H. muelleriana* of the second group approaches the first group more closely by its fruit shape and is intermediate in the extent of the ridge on the seed.

Within the first group, *H. ulicina* appears to posses the more primitive attributes in terms of breeding system in its reliance on sexual reproduction. The complete dependence on vegetative reproduction in *H. aenigma* is obviously an evolutionary end-point (e.g. Grant 1971). However, *H. aenigma* shows a probably primitive trait in the lack of twisting of the leaf base. Its leaf vascular arrangement in having paired strands, is different from all the other species examined. Whether there is a parallel development of unisexuality and partial dependence on vegetative reproduction in the second species group needs further investigation.

Taxonomic Treatment

Bentham (1870) included *H. ulicina* and *H. carinata* (as *H. ulicina* var. *carinata*) in his Series *Nervosae* of *Hakea* Section *Conogynoides*. There is no reason to doubt that *H. ulicina* is related to the other species included in this series: *H. plurinervia* F.Muell., *H. dactyloides* (Gaertner)Cav., *H. falcata* R.Br. and *H. pycnoneura* Meissner, all non-South Australian species. However, although Bentham included *H. muelleriana* (as *H. flexilis*) with Western Australian species in Series *Teretifoliae* it clearly belongs with *H. ulicina*. Furthermore, species such as *H. ambigua* Meissner and *H. stenocarpa* R.Br. from nearby series seem to relate more closely to species of Series *Nervosae*. Bentham's infrageneric classification clearly needs re-appraisal. For the purposes of this account, a key distinguishing the *H. ulicina* complex from other *Hakea* found in South Australia and separating the species within the complex, is provided.

Key to Species of *H. ulicina* Complex in South Australia

1. Pollen presenter erect [inflorescences with 8-36 flowers, the rhachis 0.25-1 cm long; pistils 3-8.5 mm long; perianth glabrous outside; leaves simple].
   2. Leaves with usually 3-5 longitudinal veins (rarely only the midvein) on the upper side as prominent as the vein on the lower side; plant suckering; seed, if present, with ridge absent or very short.
      3. Leaves 5-35 cm, usually 9-23 cm long, not twisted; inflorescence-involucre 6-10 mm long, rhachis 2.5-4 mm long; pedicel 3-5 mm long; fruits never developing ..... *H. aenigma* 1.
      3. Leaves 4-10.5 cm, rarely to 14 cm long, twisted at the base; inflorescence-involucre 2.5-5 mm long, rhachis 1-2 mm long; pedicel 1.8-3.1, rarely to 3.6 mm long; fruits able to develop .... *H. repullulans* 2.
   2. Leaves with the upper side excluding margins lacking prominent veins or midvein, rarely on broad leaves the veins of the lower side showing through faintly when dried; plant not suckering; seed with a ridge extending one-third to halfway to the apex of the wing.
      4. Fruit in median view elliptic to narrowly ovate-elliptic, gradually attenuated into narrow beak; beak fragile, 4-6.5 mm, rarely 3 mm long; seed wing evenly dark-brown .... *H. carinata* 4.
      4. Fruit in median view oblong- to ovate-elliptic, often broadly so, usually with a protuberance on either side of the apex in median view below the beak; beak 1-2.5 rarely 4 mm long; seed wing light-brown with dark-brown streaks ..... *H. muelleriana* 3.
1. Pollen presenter oblique or erect [if erect then either inflorescences with 50-100 flowers, (the rhachis 2-9 cm long), pistils 14-19.5 mm long (*H. francisiana, H. laurina, H. minyma*), or perianth pubescent outside and leaves compound (*H. ednieana*)] .... Other species of *Hakea* in South Australia.

1. **Hakea aenigma** W.R. Barker & Haegi, sp. nov.

'*H.* near *H. multilineata*, Meisn.': Cleland & J. Black, Trans. Roy. Soc. S.Austral. 51 (1927) 35 (as to *Cleland AD 97111126*).

H. multilineata auct. non Meissner: J.Black, Fl. S.Austral. edn 2 (1948) 267, p.p. (as to 'Kangaroo Island (Flinders Chase)'); Wood, Trans. Roy. Soc. S.Austral. 54 (1930), p.p. (as to 'W').

?'*Hakea ulicina* .... var. nov.': Cleland, Plants of Kangaroo Island (Aug. 1967) 6.

'*H.* cf. *francisiana* FvM.': Maconochie, Trans. Roy. Soc. S.Austral. 97 (1973) 132, 133.

'*Hakea* sp.': W.R. Barker in Jessop, List. Vasc. Pl. S.Austral. (1983)75.

Frutex *H. ulicinae* sensu lato affinis surculis lignotubere et systemate horizontali radicum exorientibus floribus omnino sterilibus, fructibus haud evolutis, sed differt inter alia foliis longioribus (5-35 cm cf. 4-10.5 cm) basi non tortilibus, involucro inflorescentiae longiore (6-10 mm cf. 2.5-5 mm), rhache longiore (2.5-4 mm cf. 1-2 mm).

Holotypus: *W.R. Barker 4479 & L. Haegi*, 6.x.1982, 'South Australia. Region 12: Kangaroo Island. 35°49′S, 136°46′E. Flinders Chase; Shackle Road, ca. 2.8km by road S of Playford Highway, ca. 1.5 km by road NNE of N crossing of Bull Creek'. AD 98346065. *Isotypi*: MEL, NSW, K, CANB, PERTH.

Compact shrub to 2.5 m high, with ascending smooth branches, suckering from a lignotuber and a horizontal root system; *branchlets* with a more or less appressed tomentum persisting at least until flowering sometimes patchily glabrescent; *leaves* ascending, flat, narrow-linear to linear, 5-35 cm x 3-10 mm, not consistently twisted at the base, with 1-6 longitudinal veins above, 4-9 veins below, mucro 0.7-1.5 mm long; *involucral cone* ovoid, 6-10 mm long, apex and margins of bracts white-hirsute; *racemes* with 16-33 cream-white flowers; *rhachis* 2.5-4 mm long, white hirsute; *pedicel* 3-5 mm long; *perianth* 3-3.5 mm long, limb 0.8-1.1 mm long; *anthers* 0.5-0.6 mm long; *gland* absent; *pistil* 4.5-7.2 mm long;

pollen-presenter a narrow cone 0.5-0.8 mm long, dilated slightly at the base into a narrow flange 0.45-0.7 mm diam.; *fruits* never forming. Figs 7, 9.

Distribution and Ecology (fig. 10).

H. aenigma is confined to the western end of Kangaroo Island where it occurs on the upper parts of a lateritic plateau system. It is found in dense, heathy mallee-shrubland or sometimes on open sites regenerating after fire, on sandy to clayey loam soils of the Dy 5.41 type (Northcote 1960). Flowering occurs from late September to early November.

Conservation Status

Although *H. aenigma* is known from several populations, with one to in the order of one thousand individuals (R. Davies, pers. comm. 1983), none of these is extensive in area and the species is restricted to a relatively small region. With no sexual reproduction and propagation being solely by suckering the species is highly uniform genetically, as seen in its limited morphological variability. It therefore lacks the genetic resilience of sexually reproducing species. *H. aenigma* may be considered rare but does occur in the Flinders Chase Conservation Park. Applying the criteria of Leigh et al. (1981) it is assigned the conservation status 2RC.

Notes

1. The species epithet is from the Latin *aenigma*, a riddle, in reference to the puzzlingly unsuccessful repeated searches for fruits, the unusual life-history of the species and the long uncertainty about its identity and affinities.

2. In its fullest form the authority for this species is 'W.R. Barker & Haegi in Haegi & W.R. Barker, J. Adelaide Bot. Gard., etc.'

3. The restriction of *H. aenigma* with its solely vegetative mode of reproduction to an off-shore island begs the question why the capacity to reproduce sexually was lost. More work is required to answer this. Is there evidence of high polyploidy? Are pollinators such as work on *H. repullulans* present on Kangaroo Island?

With the closest of its nearest relatives, *H. repullulans*, occurring in the Upper South-East of mainland South Australia, *H. aenigma* or its progenitor must have arrived on the island during a period when the sea-level dropped sufficiently to allow a linking land bridge; such periods have occurred several times during the Pleistocene (Daily et al. 1979; Bowler 1982).

Despite the limited capacity of *H. aenigma* to spread because of its reliance on suckering from horizontal roots, it has attained a range of approximately 30 x 15 km. Effectively a single clone, the species could represent one of the oldest plants known.

Specimens examined

SOUTH AUSTRALIA. KANGAROO ISLAND: *Anon. per J.B. Cleland s.n.*, x.1965, Flinders Chase (AD); *W.R. Barker 4479 & L. Haegi*, 6.x.1982, Flinders Chase; Shackle Road, ca 2.8 km by road S of Playford Highway, ca 1.5 km by road NNE of N crossing of Bull Creek; ca 13 km direct NNE of Rocky River (AD, holotype); *C. Baxter A-C*, xii.1982, same locality as *Barker 4479* (AD.); *C. Baxter D-F*, xii.1982, same locality as *Haegi 2287* (AD); *C. Baxter G-H*, xii.1982, same locality as *Haegi 2288* (AD); *J.B. Cleland (Herb. J.M. Black) s.n.*, xi.1924, Flinders Chase (AD 97111126); *J.B. Cleland s.n.*, 27.xi.1954, Shackle Road, Flinders Chase (AD 96807235); *N. Coles 63*, 19.x.1965, Shackle Road, 2 miles (ca 4 km) in from Playford H[ighway] (AD); *B.J. Conn 1085*, 14.xi.1980, Watters' mail box, Western River headwaters (AD); *P. Copley s.n.*, i.1982, ridge W of Western River (West Branch), ca three-quarters km NNE of entry road to 'Yakilo' farm, ca 5 km direct NNE of turnoff from Playford Highway, on road to Waterfall Creek and Red Hill, (AD 98346066); *R. Davies 14 & W. Bushman*, 6.x.1983, 3.0 km east of West Bay Road along road to Larrikin Lagoon (AD); *L. Haegi 410-411*, 12.iv.1973, 25 km directly north of Karatta on a road running parallel to and situated 5 km north of the Playford Highway, near the source of Western River (AD); *L. Haegi 2287 & W.R. Barker*, 6.x.1982, Flinders Chase Conservation Park, 3 km WNW of Shackle Road turnoff along Playford Highway to Cape Borda (AD); *L. Haegi 2288, 2288A & W.R. Barker*,

Fig. 7. Holotype of *H. aenigma*, sp. nov. (*Barker 4479 & Haegi*; scale 5 cm).

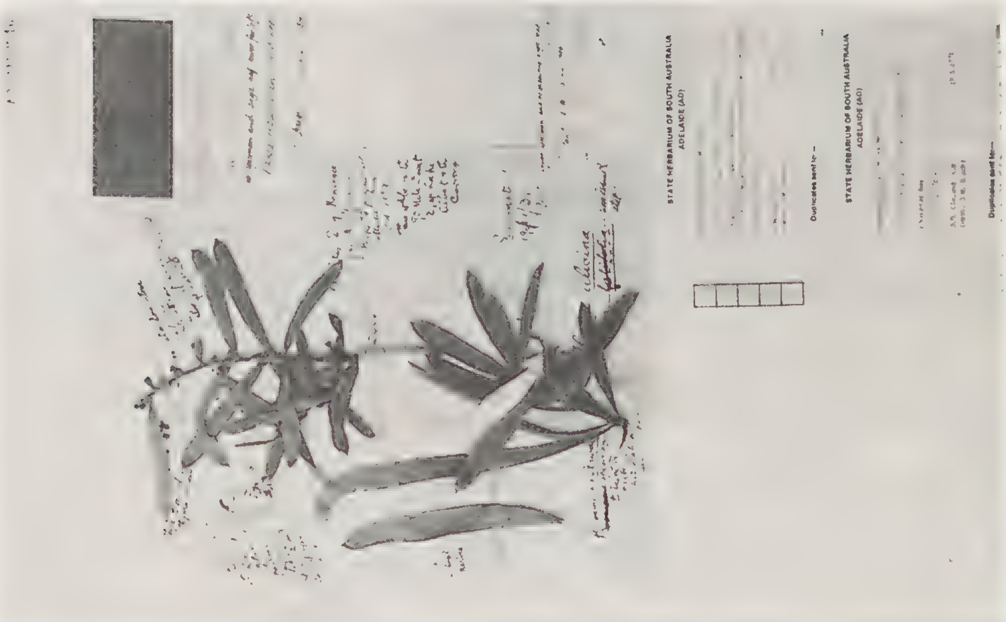


Fig. 8. Holotype of *H. ulicina* var. *latifolia* J. Black (*J.B. Cleland* per *A. Morris 2405*; scale 5 cm).

7.x.1982, Watters' mail box, on east-west road 3.2 km direct E of turnoff from Western River Cove road, ca 4.5 km direct NE of junction of Playford and West End Highways (AD); *G. Jackson 1081, 1082*, 7.xi.1976, Watters mail box near roadside, Western River Road (AD); *G. Jackson 1113*, 16.v.1977, on road to Western River Reserve about halfway between first farm, Yankillo Downs, and second farm, Colmar (AD); *G. Jackson 1143-1145*, 13.x.1977; *1212*, 23.ix.1979; 1506 1.xi.1981, Watters' mail box, road parallel to and north of Playford Highway, Hundred of Gosse (AD); *G. Jackson 1671*, 11.x.1984, Rex Ellis' property, Hundred of Borda, [up to ca 1 km E of trig T1/834 on 1:50,000 'Borda' Map] (AD); *G. Lonzar per J.B. Cleland s.n.*, 3.xii.1956, Flinders Chase; Shackle Road (AD 96225061, AD 98347057).

2. **Hakea repullulans** H.M. Lee, Austral. J. Bot. 32 (1984) 681. *Holotype*: *H.M. Lee 137*, 18.x.1979, Chimney Pot Gap, 40 km SW of Halls Gap, Grampians, Victoria (MEL, n.v.)

H. ulicina R. Br. var. *latifolia* J. Black, Trans. Roy. Soc. S. Austral. 54 (1930) 59; J. Black, Fl. S. Austral. edn 2 (1948) 266-267, p.p. (excl. 'Encounter Bay and near Goolwa'); Beek & Foster, Wildfl. S. Austral. (1972), p.p. (excl. 'Encounter Bay', 'Goolwa'); J.H. Willis, Handb. Pl. Victoria (1973) 49; Costermans, Native Trees & Shrubs S.E. Austral. (1981) 115, p.p. (as to 'Grampians', 'Deserts'), 155, p.p. (excl. 'Fleurieu Peninsula', Kangaroo Island—map).

Type citation: 'Ninety Mile Desert, near the Coorong; coll. E. Ashby.'—*Holotype*: *E. Ashby* [fide J. Black, protologue] *per A. Morris 2405*, Oct. 1929, 25 miles [c. 40km] E of Meningie, 'in the 90 mile desert E of Lake Albert and the Coorong'. (AD 98132246: top specimen).

H. ulicina auct. non R. Br.: Benth., Fl. Austral. 5 (1870) 524, p.p. (as to 'Glenelg River', 'Mount Sturgeon', 'Mount Abrupt'); J. Black, Fl. S. Austral. (1929) 161 p.p. (as to 'Eastern States' in part); Ewart, Fl. Victoria (1931) 408, p.p. (as to 'Grampians'); Specht, Veg. S. Austral. (1972) 250, p.p. (as to 'Heath Formation, Upper South East, in part); J.H. Willis, Handb. Pl. Victoria (1973) 49, p.p. (as to 'western .... Victoria', 'Lower Glenelg R.', 'Little Desert, Black Range & Grampians, Portland district' and, in part, 'Otways'); Haegi, Tax. Study *Hakea ulicina* Complex (1973) 56, p.p.; W.R. Barker in Jessop, List Vasc. Pl. S. Austral. (1982) 75.

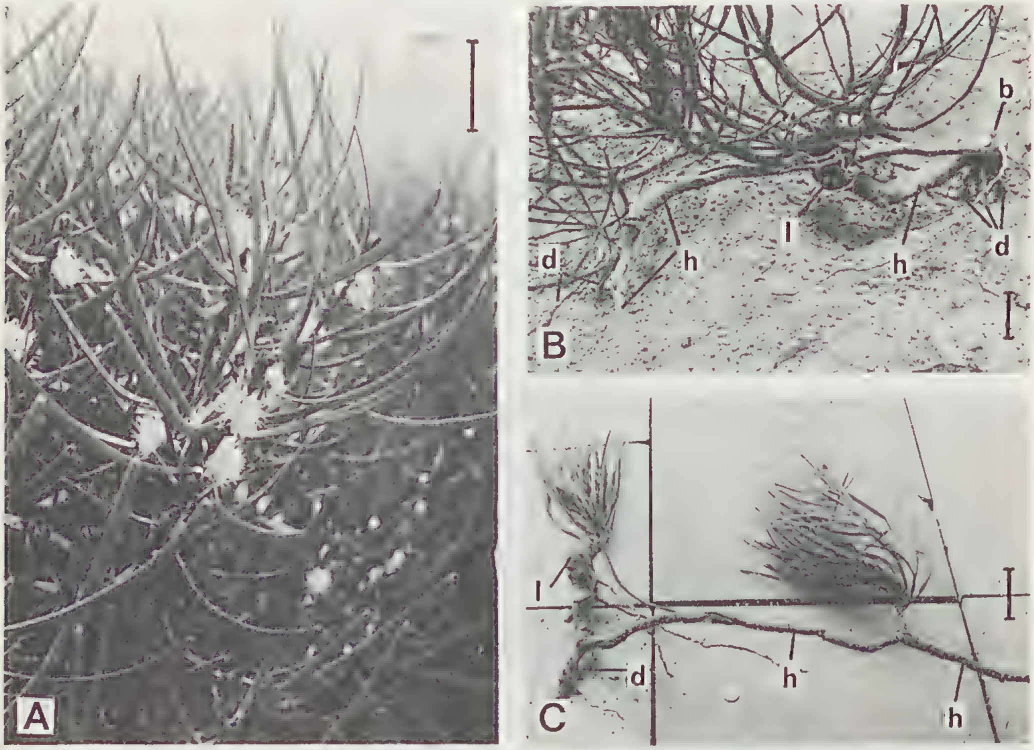


Fig. 9. *H. aenigma*. A, flowering branch (*Haegi 2288*; scale 5 cm); B, excavated root-system of mature shrub (*Haegi 2287*; scale 10 cm); C, suckers developed from lignotuber and horizontal root after fire (*Haegi 2287*; scale 10 cm); l, lignotuber; h, horizontal root; d, downturned root; b, base of earlier shrub.

Erect open shrub c. 2 m high, producing suckers; *branches* ascending; *branchlets* with tomentum persistent at least until flowering; *leaves* widely spreading, linear, 4-14 cm x 1.5-12 mm, twisted through 90 degrees at base, with 1-5 longitudinal veins above and below, mucro 1-4 mm long; *involucral cone* ovoid to spherical, 2.5-5 mm long, bracts with the apex woolly-tomentose and margin ciliate; *racemes* with 10-28 flowers; *rhachis* 1-2 mm long, white-hirsute; *pedicel* 1.8-3.6 mm long, rarely pubescent; *perianth* 1.7-4 mm long, limb 0.9-1.2 mm diam.; *anthers* 0.4-0.6 mm long; *gland*0.1-0.5 mm high; *pistil* 4-5.7 mm long; *pollen-presenter* a cone 0.5-0.9 mm long, with a basal flange 0.3-0.6 mm diam.; *fruit* ellipsoid to ovoid, often broadly so, 1.6-2.5 cm long, in lateral view 1-1.3 cm wide, in median view 1.3-1.8 cm wide, often black-pusticulate, with a slight protuberance on either side in median view near the base of the 1-2.5 mm long fragile beak; *seed* obliquely ovate, 10-16 x 3.5-6.5 mm, body broad-elliptic to ovate-elliptic, c. 1.9 mm thick, ridge inconspicuous, almost absent, wing decurrent further and more broadly down one side of the body, evenly blackish-brown. Figs 5, 6, 8.

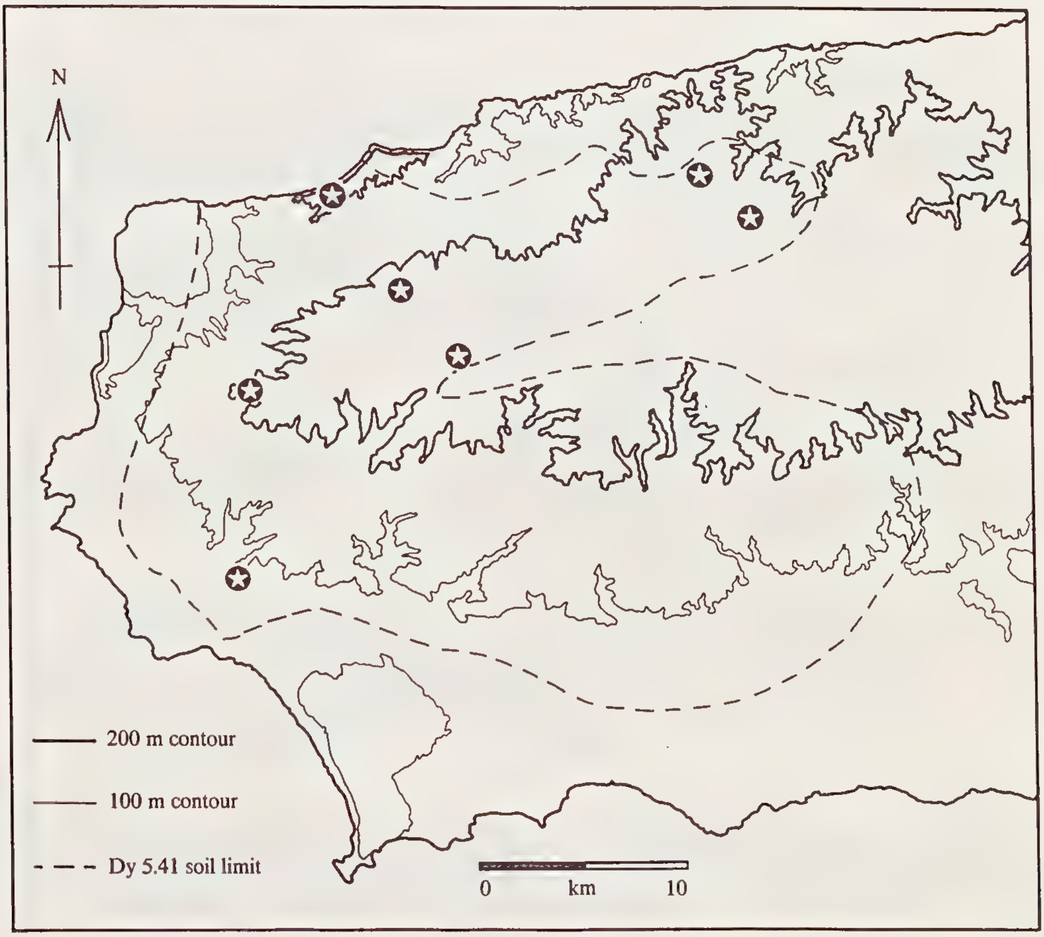


Fig. 10. Distribution of *H. aenigma* on western Kangaroo Island showing confinement to lateritic uplands, particularly on duplex soils of the Dy 5.41 type (limit after Northcote 1960).

Distribution and Ecology (fig. 11)

The major part of the distribution of *H. repullulans* is in sclerophyllous forest and mallee-heath in central and western Victoria. In South Australia its occurrence is restricted to mallee-heath on sandy soils of the South-Eastern region, where populations are small and somewhat scattered. Flowering occurs during September and October.

Note

The holotype of *H. repullulans* has not been seen but that of the taxonomic synonym *H. ulicina* var. *latifolia* has (fig. 8). The latter is cited by Black (1930) as having been collected by E. Ashby. This name, however, does not appear on the only specimen from Black's herbarium in AD labelled by Black as *H. ulicina* var. *latifolia* and from the type locality. The relevant specimen is labelled 'per A. Morris of Broken Hill and presumably collected by him' and bears the number 2405, presumably Morris's. It seems likely that Black ascertained that Morris had acquired the specimen from Ashby (who was the collector) but failed to annotate the specimen, which is regarded as the holotype. No duplicate of the specimen has been found in the Morris herbarium which is housed at ADW (D.E. Symon, pers. comm. Dec. 1984).

Specimens examined

SOUTH AUSTRALIA. SOUTH-EASTERN: *A.C. Beauglehole 7366*, 12.x.1963, Hundred of Coles (AD); *J.B. Cleland s.n.*, 9.iii.1963, Reserve, 5 miles (ca 8 km) east of Salt Creek (AD); *N.N. Donner 9251*, 9.x.1982, ca 8 km NE of Lucindale (AD); *L. Haegi 534, 535*, 22.ix.1973, 6 km east of Woods Well on Culburra-Woods Well Road, ca 0.5 km north of the road (AD); *D. Hunt 917*, 14.vii.1962, north of The Gap, Bordertown to Naracoorte road (AD); *D. Hunt 1212*, 6.x.1962, Bordertown to Naracoorte road (AD); *D. Hunt 2477*, 19.ix.1965, east of Penola Durradong road (AD); *E.H. Ising s.n.*, 13.xii.1934, Lucindale (AD); *R.H. Kuchel 2733*, 8.ix.1968, Messent Wild Life Reserve (AD); *A. Morris 2405 (Herb. J.M. Black)*, x.1929, 25 miles (ca 40 km) E of Meningie (AD 98132246 p.p., holotype of *H. ulicina* var. *latifolia* J. Black); *A.E. Orchard 1013*, 8.viii.1968, Mt Rescue National Park, ca 16 km north of Keith (AD); *R.L. Specht 26 & P. Rayson*, x.1950, Dark Island heath, ca 15 km north-east of Keith (AD); *A.G. Spooner 5380*, 10.x.1977, Messent Conservation Park (AD); *D.E. Symon 10754*, 2.x.1977, Mt Shaugh Conservation Park near 35°49'S, 140°56'E (AD); *D.E. Symon 10781*, 3.x.1977, about 3 km NE of 'Tamboore' and about 7 km due S of Mt Rescue (AD); *D.E. Symon 10928*, 8.x.1977, 90 Mile Desert, 10 km N of Kirra boundary (AD); *R.M. Welbourn 191*, 25.x.1964, ca 40 km N of Naracoorte (AD).

VICTORIA. WESTERN HIGHLANDS (GRAMPIANS): *Anon. (Herb. J.M.Black) s.n.*, 1927, Stawell (AD 97337146); *E. & A.K. Ashby 153*, xi.1940, Grampians (AD); *W.R. Barker 4601 & R.M. Barker*, 1.ix.1983, below turnoff to Sundial Peak from the main Wartook-Lake Bellfield road (AD); *L. Haegi 641*, 18.iv.1975, ca 10 km NNE of Victoria Valley Hamlet on road running along eastern side of Victoria Range (AD); *E.N.S. Jackson 1494, 1518*, 25.x.1969, near Mt Difficult on Roses Gap Road (AD); *A.G. Spooner 4865*, 24.x.1976, on Dunkeld to Hall's Gap road 37°22'S, 142°25'E, AD.

3. **Hakea muelleriana** J. Black, Fl. S.Austral. edn 2 (1948) 267 (substitute name for *H. flexilis* F. Muell.); H. Eichler, Suppl. Black's Fl. S. Australia (1965) 96; Specht, Veg. S. Austral. (1972) 250, 274; Haegi, Tax. Study *Hakea ulicina* Complex (1973) 62; J.H. Willis, Handb. Pl. Victoria 2 (1973) 53; Costermans, Native Trees & Shrubs in S.E. Austral. (1981) 110, 156; W.R. Barker in Jessop List Vasc. Pl. S. Austral. (1982) 75.

Type: see *H. flexilis* F. Muell. below

H. flexilis [auct. non R. Br.: F. Muell. ex Meissner, Linnaea 26 (1854) 359; F. Muell. ex Meissner in DC. Prodr. 14 (1856) 415 'flexibilis'] F. Muell., Fragm. Phyt. Austral. 6 (1868) 216, nom. illeg. non R. Br.; Benth., Fl. Austral. 5 (1870) 530; Tepper, Trans. Roy. Soc. S. Austral. 3 (1880) 39; Tate, Trans. Roy. Soc. S. Austral. 3 (1880) 68, 6 (1883) 138, 160; J. Black, Trans. Roy. Soc. S.Austral. 40 (1916) 59; Ewart, Fl. Victoria (1931) 408, p.p. (excl. S. Victoria; N.S.Wales record not substantiated).

Type citation (Meissner 1856): 'In deserto ad flum. Murray crescens.' *Type material*: to be searched for in the Meissner herbarium, NY. *Possible duplicates of the type*: *F. Mueller*, River Murray (MEL 55874, 55876, s.n.); *F. Mueller*, In the Murray Desert (MEL 55875); *F. Mueller*, 1849, Murray Scrub (MEL).

H. ulicina R. Br. var. *flexilis* (F. Muell.) C. Moore & Betche, Handb. Fl. New South Wales (1893) 243; J. Black, Trans. Roy. Soc. S. Austral. 41 (1917) 42, 42 (1918) 42, 43 (1919) 29, 350; Wood, Trans. Roy. Soc. S. Austral. 54 (1930) 130, p.p. (as to 'W', 'C' 'E.Aust.'; Ising, Trans. Roy. Soc. S. Austral. 59 (1935) 244; J. Black, Fl. S. Austral. (1924) 161, p.p. (excl. 'Southern part of Flinders Range').

H. ulicina auct. non R. Br.: Tate, Trans. Roy. Soc. S. Aust. 12 (1889) 90, p.p. (as to 'Y', 'L', 'K' and, in part, 'T'); Tate, Fl. Extratrop. S. Austral. (1890) 94, 228, p.p. (as to 'Y', 'K' and, in part, 'T'); Wood, Trans. Roy. Soc. S. Austral. 54 (1930) 130, p.p. (as to 'W', 'C', 'Pt. L.'); Baldwin & Crocker, Trans. R. Soc. S. Austral. 65 (1941) 273, 274; Specht, Veg. S. Austral. (1972) 274.

H. ulicina var. *carinata* auct. non (F. Muell. ex Meissner) Benth.: Tepper, Trans. Roy. Soc. S. Austral. 9 (1887) 115.

H. marginata auct. non R. Br.: Tepper, Trans. Roy. Soc. S. Austral. 10 (1885) 291.

H. corymbosa auct. non R. Br.: Tate, Trans. Roy. Soc. S. Austral. 12 (1889) 63.

Erect rounded shrub 1-4 m high, not suckering; *branchlets* appressed-pubescent initially, glabrous by the time of flowering (apart from new shoots); *leaves* widely spreading, rarely ascending, terete with no veins apparent to 3-angled, narrow-linear, with marginal veins and mid-vein on lower side conspicuous, rarely flat and obovate-linear, 3.5-12 cm x 1-10 mm, mucro 1-2.5 mm long; *involucral cone* 2-4.5 mm long, with bracts appressed-pubescent all over or at the apex, densely white-ciliate; *racemes* with 16-36 flowers; *rhachis* 1-2.5 mm long, white-hirsute; *pedicel* 1.5-2.7 mm long, pink; *perianth* 2.1-4 mm long, white to yellow, limb 0.9-1.2 mm diam.; *anthers* 0.35-0.7 mm long; *gland* 0.1-0.5 mm high; *pistil* 4.5-6.2 mm long; *pollen-presenter* a cone 0.5-0.7 mm long, basal flange 0.3-0.7 mm diam.; *fruit* ellipsoid to ovoid-ellipsoid, often broadly so, 1.2-2.5 cm long, in lateral view 0.5-1.3 cm wide, in median view 0.7-1.6 cm wide, black-pusticulate, with a slight protuberance on either side in median view below the 1-3.5 (-4) mm long fragile beak; *seed* obliquely elliptic, 8-15 x 3.5-6 mm, body elliptic to ovate-elliptic, c. 1.6 mm thick, ridge at the base half the thickness of the body, extended a third way to the wing apex, wing decurrent more broadly and further down one side of the body, light-brown with dark streaks, rarely dark-brown. Figs 3, 6.

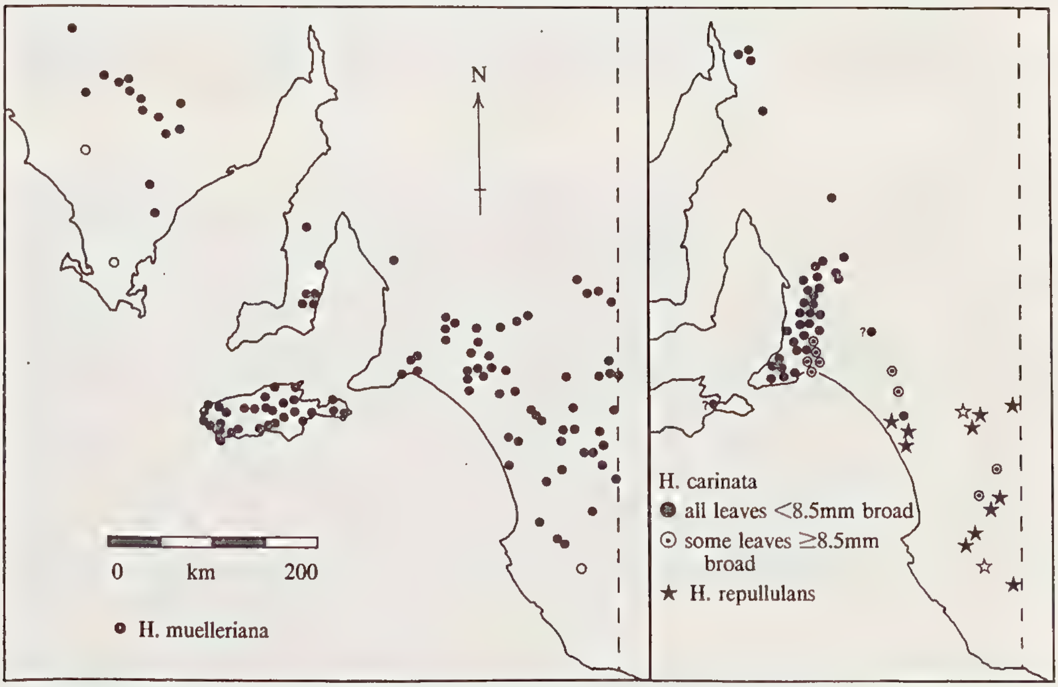


Fig. 11. Distributions of *H. muelleriana, H. carinata* and *H. repullulans* in South Australia. Hollow symbols indicate imprecise localities.

Distribution and Ecology (fig. 11)

The distribution of *H. muelleriana* extends from Eyre Peninsula to north-western Victoria and Kangaroo Island. It occurs in dry though not arid regions, bounded approximately by the 250 mm and 500 mm isohyets. Records of the occurrence of *H. muelleriana* in New South Wales (e.g. Willis 1973) are apparently in error. This species is found in mallee-heath vegetation, often as a moderately common, conspicuous component, on sandy soils. On Kangaroo Island it has also been recorded from dry sclerophyll forest. On the mainland flowering occurs principally in November, beginning in late October and extending only a few days into December. On Kangaroo Island, where many species flower later than on the mainland, the flowering season is December and January.

Note

The name *H. muelleriana* is based on '*H. flexilis* F.v.M. (1853)' (Black 1948). This reference is evidently to the observation by Meissner in Linnaea volume 26 (published during 1853 and 1854) of what he believed to be the misidentification by Mueller of a specimen as *H. flexilis* R. Br. No description appears at this place and therefore Black's reference may be taken as an indirect one to a subsequent mention by Meissner (1856) of Mueller's specimen, where the earlier observation is cited and a Latin description is provided (satisfying the requirements of the International Code).

A complication arises through Meissner's (1856) use or at least the appearance in the text of the spelling '*H. flexibilis* Ferd. Mull.' Whether this is a printing error (as it is taken as by Bentham, 1870 and Eichler, 1965), an error on Meissner's part, or even the partly intentional proposal by Meissner of a provisional name for what he believed to be possibly a new species, it is at best an invalid name, not validated before the publication of *H. muelleriana*. In a brief note Mueller (1868) was the first to decide firmly that the material from the Murray River region, originally misidentified as *H. flexilis* R.Br., was a distinct species and took up the name *H. flexilis* F. Muell. for it, not using Meissner's spelling '*flexibilis*'.

Although there is no direct reference, Mueller's (1868) '*flexilis*' can also be taken to be based on Meissner's (1856) description. In the same publication, Mueller (1868) frequently referred to Meissner's (1856) work, but saw no need, in contrast to other species newly described, to provide a full description for *H. flexilis*.

Selected specimens

SOUTH AUSTRALIA. EYRE PENINSULA (47 specimens seen): *C.R. Alcock 582*, 6.vii.1965, Hundred of Wanilla, Section 125 (Reserve) (AD); *C.R. Alcock 4049*, 3.x.1972, Gawler Ranges, off main road ca 25 km south of Yardea Homestead, ca 1 km north of Scrubby Peak (AD); *W.R. Barker 3556*, 23.ix.1978, ca 32 km by road S of Kimba on the Cleve road, ca 1 km WNW of Mt Bosanquet (AD); *H.C. Robjohns s.n.*, 24.x.1967, Point Bolingbroke (AD); *K.D. Rohrlach 693*, 18.x.1959, County Buxton, Hundred Pinkawillinie, south of Section 95, ca 24 km west-north-west of Kimba (AD). MURRAY (43 specimens): *Hj. Eichler 12368*, 12.iv.1956, ca 37 km north of Pinnaroo, on road from Loxton to Pinnaroo, near Peebinga (AD); *L. Haegi 260*, 30.iii.1973, ca 5 km south of Monarto South on road to Ferries McDonald Conservation Park (AD); *E.N.S. Jackson 2322*, 14.xi.1972, Billiatt Conservation Park (AD); *M.C.R. Sharrad 1239*, 31.x.1961, 6 miles (ca 9 km) west of Coomandook (AD). YORKE PENINSULA (14 specimens): *B. Copley 2881*, on boundary road between Hundred of Wiltunga and Hundred of Cameron, south of railway line (AD); *B. Copley 4647*, 20.x.1974, on road running east-west from 2 km south of Weetulta to 1 km south of Arthurton (AD); *E. Giankos per B.Copley 4193*, near Pine Point (AD); *T.Hall 46*, 26.x.1982, Cut Line Road, (on the 34°53'S, parallel), between Stansbury and Hardwicke Bay (AD). SOUTHERN LOFTY (19 specimens): *J.B. Cleland s.n.*, xi.1921, Goolwa, AD 97210017, AD 966130111.-*L. Haegi 265*, 9.ii.1973, 8.5 km north-east of Two Wells and 4 km south-south-east of Reeves Plains (AD); *L. Haegi 274*. 20.ii.1973, 4 km NW of Currency Creek P.O. on track to Mosquito Hill (AD); *D.Hunt 3425*, 30.x.1972, road connecting Currency Creek and Middleton (AD); *A.G. Spooner 972*, 18.xi.1970, Finniss Scrub (AD). KANGAROO ISLAND (111 specimens): *L. Haegi 322-323*, 7.iv.1973, 34 km by road SW of Kingscote on South Coast Road., 2 km due east of intersection with Birchmore Hwy (AD); *L. Haegi 336-343*, 8.iv.1973, 1.2 km NW of Point Ellen on Vivonne road, at Vivonne Bay (AD); *L. Haegi 360*, 9.iv.1973, 3.2 km W of Karatta (AD); *L. Haegi 395-398*, 11.iv.1973, roadside near Remarkable Rocks (AD); *L. Haegi 404-406*, 11.iv.1973, near entrance to Lighthouse Station at Cape Borda (AD); *L. Haegi 422*, 13.iv.1973, 4 km W of Cape Willoughby, Dudley

Peninsula (AD). SOUTH-EASTERN (63 specimens): *D. Hunt per R.M. Welbourn 176*, 12.xii.1963, Lucindale (AD); *L.Haegi 250, 251, 253*, 5.xii.1972, ca 3 km east of Meningie on road to Coonalpyn (AD); *L. Haegi 254*, 5.xii.1972, ca 16 km W of Coonalpyn on road to Meningie (AD); *T. Roach 60*, 21.xi.1970, ca 32 km south of Keith near Willalooka Store (AD); *J.G. West 2233*, 2.x.1977, Mt Shaugh Conservation Park, 2 km south-east of Mt Shaugh and 2 km west of Victorian border (AD);*P. Wilson 1419*, 22.xi.1959, Ashville, ca 20km N of Meningie.

VICTORIA (14 specimens): *A.C. Beauglehole 25239*, 28.v.1968, Grampians, Black Range, 2 mls S of Mt Talbot, 1.1 mls W of road junction [which is] at a point 2 mls SSE of Mt Talbot (AD); *A.C. Beauglehole 28711*, 1.x.1968, Wyperfeld National Park, Dattuck Track, 2 miles ENE of Eastern Lookout (AD); *E. & G. Gardiner s.n.*, 27 km S of Murrayville (AD 98151113).

4. **Hakea carinata** F. Muell. ex Meissner, Linnaea 26 (1854) 360 (incl. α *planifolia* Meissner and β *trigonophylla* Meissner); Meissner in De Candolle, Prodr. 14 (1856) 418; F.Muell., Fragm. Phyt. Austral. 4 (1868) 315; Haegi, Tax. Study *H. ulicina* Complex (1973) 49; W.R.Barker in Jessop, List. Vasc. Pl. S.Austral. (1982) 75.

Type citation: 'Lofty Range, Adelaide, Octob. Brighton, Austr. fel., Octob.'—*Lectotype* (here designated): F.Mueller, 1851-52, Lofty Range, Adelaide, ex Herb. W. Sonder (NY: Meissner Herb., specimen on far left side; mounted with 2 other *syntypes*—no further locality data on sheet). Probable isosyntypes including possible isolectotype(s): MEL 55892, 55907, 55908, 55911, 55913; S.

H. ulicina R. Br. var. *carinata* (F. Muell. ex Meissner) Benth., Fl. Austral. 5 (1870) 24.

H. ulicina auct. non R. Br.: Tate, Trans. Roy. Soc. S. Austral. 3 (1880) 68; Anon., Trans. Roy. Soc. S. Austral. 9 (1887) 278; Tate, Trans. Roy. Soc. S. Austral. 9 (1887) 278; Tate, Trans. Roy. Soc. S. Austral. 12 (1889) 90, p.p. (as to 'A', 'N' and, in part, 'T'); Tate, Fl. Extratrop. S. Austral. (1890) 84, 228, p.p. (as to 'A' and, in part, 'T'); J. Black, Fl. S. Austral. (1924) 161, p.p. (excl. 'Eastern States', var. *flexilis*), (1929) 682; Wood, Trans. Roy. Soc. S. Aust. 54 (1930) 130, p.p. (as to 'Fl', 'Fl G'; Ewart, Fl. Victoria (1931) 408, p.p.; J. Black, Fl. S. Austral. edn 2 (1948) 266, p.p. (excl. 'Murray Lands', 'Eastern States'); Specht, Veg. S. Austral. (1972) 250, p.p. (excl. 'Heath formation, Upper South East' in part); J.H. Willis, Handb. Pl. Victoria 2 (1973) 49, p.p. (as to 'S.A. (as far west as Mt Lofty)' in large part).

H. ulicina R. Br. var. *latifolia* auct. non J.Black: J. Black, Fl. S. Austral. edn 2 (1948) 266-267, p.p. (as to 'Encounter Bay and near Goolwa'); Beek & Foster, Wildfls S. Austral. (1972), p.p. (as to 'Encounter Bay and near Goolwa'); Costermans, Native Trees & Shrubs in S.E. Austral. (1981) 115, 155, p.p. (as to 'Fleurieu Peninsula').

Erect often unevenly branched shrub 1.5-3 m high, not suckering; *branchlets* with appressed-pubescence persisting at least until flowering, sometimes patchily glabrescent; *leaves* narrow-linear to narrow-trigonous, rarely broad-linear, 5-24 cm x 1-12 mm, base not twisted, marginal veins conspicuous, mid-vein prominent below, rarely with 3 longitudinal veins prominent below and faintly conspicuous in dried material above, mucro 0.5-2.5 mm long; *involucral cone* 3.5-5 mm long, with the apex of the bracts appressed-white-pubescent, densely ciliate; *racemes* with 8-24 flowers; *rhachis* 1-2 mm long, white-hirsute; *pedicel* 1.5-3.5 mm long, rarely sparsely pubescent, pinkish; *perianth* 1.9-2.8 mm long, cream-white, limb 0.9-1.4 mm diam.; *anthers* 0.4-0.6 mm long; *gland* 0.1-0.4 (-0.8) mm high; *pistil* 3-6 mm long, cream-white; *pollen-presenter* a cone 0.5-0.8 mm long, with a basal flange 0.5-0.8 mm diam.; *fruit* ellipsoid to narrowly ovoid-ellipsoid, 1.3-2.6 x 0.6-1.1 cm, smooth or minutely verrucose, gradually attenuated into a fragile beak (3-) 4-6.5 mm long; *seed* obliquely ovate to elliptic-ovate, 10-18 x 4-6.5 mm, body almost globular, c. 2.4 mm thick, ridge at base a third of the thickness of the body, extended halfway to the wing apex, wing decurrent more broadly and further down one side of the body than the other, evenly dark-brown, rarely unevenly pigmented. Figs 5, 6.

Distribution & Ecology (fig. 11)

H. carinata is endemic in South Australia where its principal occurrence is in the Mount

Lofty Ranges, from the Barossa Valley to Cape Jervis. The distribution extends north with occurrences in the Tothill Ranges and the southern Flinders Ranges from near Gladstone to Mt Remarkable and vicinity. South of the Mt Lofty Ranges, it is found in small, scattered populations as far south as Padthaway in the South-Eastern region. In the main part of its distribution, *H. carinata* is common at several sites as an understorey plant in sclerophyll forest and heathy scrub, on sands and loams. Flowering occurs during September and October.

Notes

1. A single collection bearing the locality Woods Point, 15 km SSE of Murray Bridge (*Anon. AD 97732763*) represents a disjunction which requires substantiation. *H. carinata* is doubtfully recorded for Kangaroo Island on the basis of only one specimen, reputedly collected at Muston (*Cooper AD 96229335*). Collecting in recent years has failed to confirm its occurrence there.

2. Meissner (1854) described *H. carinata* from material in the Sonder herbarium. Only one sheet from Meissner's herbarium (in NY) bears this name. It consists of three pieces and has a single label indicating among other things that the material, collected by Mueller in the Mt Lofty Ranges near Adelaide, is from the Sonder herbarium. This agrees in part with the protologue, but there a second locality, 'Brighton, Austr. fel. [Australia Felix, i.e. the State of Victoria (see Wells 1848)]' is also given. The only specimen of *Hakea* in the Meissner herbarium bearing the locality 'Brighton Austr. fel.' is the type of *H. semiplana* F.Muell. ex Meissner (described in the same publication by Meissner (1854), and a synonym of *H. nodosa* R.Br., which is known to occur at that locality). Although no specimen bearing this locality known to have been seen by Meissner has been traced, specimens of *H. carinata* labelled 'Australia felix' collected by Mueller are to be found in the Sonder herbarium at MEL. Since *H. carinata* is not otherwise known from Victoria, the locality is treated as an error rather than as indicating the existence of syntypes from another species.

3. Although Meissner described the varieties *planifolia* and *trigonophylla*, these names do not appear on the type sheet or any other specimens traced. Since no infraspecific classification is proposed, the complicated typification of these names is not attempted.

Selected specimens

SOUTH AUSTRALIA. FLINDERS RANGES (18 specimens seen): *J.B. Cleland s.n.*, 28.vi.1965, Alligator Gorge (AD 96536154); *H.M. Cooper s.n.*, 15.viii.1954, Mt Remarkable (AD 97834128, AD 97834160); *P. Martinsen 57*, 8.ix.1974, Mambray Creek (AD). NORTHERN LOFTY (4 specimens): *B. Copley 3071*, 10.ix.1970, c. 8 km W of Gladstone (AD); *D.N. Kraehenbuehl 2487*, 8.ix.1973, Central Tothill Range (AD); MURRAY (5 specimens): *(Anon. School) s.n.*, 15.x.1925, Wood's Point (AD 97732763); *Schodde 1107, 1108*, 20.iv.1959, In Wirra Wirra Scrub, c. 6 km W of Springton on road to Williamstown (AD); *Tepper s.n.*, ix.1927, Keyneton (AD 97732773). SOUTHERN LOFTY (204 specimens): *H.M. Cooper s.n.*, 3.x.1943, Taperoo (AD 96608283); *L. Haegi 196*, 27.ix.1971, ½km NE of Upper Sturt Post Office (AD); *L. Haegi 228, 229, 231*, 2.xii.1972, 5.5 km west of Kangarilla on road to Blewitt Springs (AD); *L. Haegi 276, 278-283, 285, 291, 292, 295, 299, 301-303*, 1.iv.1973, an area between 4 km and 5 km south of Ashbourne along the Ashbourne to Goolwa road, more or less adjacent to the eastern boundary of Cox's Scrub Conservation Park (AD); *L. Haegi 552-554*, 23.ix.1973, Mt Barker Road near the Eagle on the Hill (Safety Ramp) (AD); *L. Haegi 2703*, 13.ix.1984, Cox's Scrub Conservation Park (seedlings; all mature plants seen killed by fire—no suckering) (AD); *L.D. Williams 10309, 10311*, 7.v.1979, 2.3 km N of W of Williamstown (AD). KANGAROO ISLAND (in need of confirmation): *H.M. Cooper s.n.*, vi.1941, Muston (AD 96229335). SOUTH-EASTERN (15 specimens): *P. Canty s.n.*, 23.x.1980, Padthaway [Conservation Park] (AD, 2 specimens); *T.J. Fatchen, A. McDonald & A.C. Robinson s.n.*, 1.x.1976, Padthaway Conservation Park (AD); *L. Haegi 256-258*, 5.xii.1972, ca 16 km west of Coonalpyn on road to Meningie (AD); *L. Haegi 532*, 22.ix.1973, at the intersection of a fourth class road running south from Field and the Culburra-Woods Well Road; ca 30 km south-west of Coonalpyn (AD); *J.R. s.n.*, 11.viii.1965, Archibald & Makin Wild Life Reserve (AD); *M.C.R. Sharrad 544*, 27.iii.1960, 5 miles east of Malinong Hall (AD).

Acknowledgments

An honours thesis (Haegi 1973) submitted to the Botany Department, University of Adelaide, resulting from studies carried out in that institution and at the State Herbarium of South Australia, formed the early basis of this work. Thanks are due to the late Miss C.M. Eardley and to Mr D.E. Symon for assistance and advice during that phase of the study.

In the studies that were required to bring the work to publication the assistance of the following people is gratefully acknowledged: Dr Hj. Eichler and Dr W.T. Stearn for their well researched advice on the nomenclature of *H. flexilis* and also to the former for encouragement from the beginning of the project to its completion; Mr C. Baxter for collecting the results of attempted field crosses between *H. carinata* and *H. aenigma* on Kangaroo Island; Mr & Mrs G. Jackson for their interest, prolonged search for fruits of *H. aenigma*, guidance in the field and accommodation; Mr G Bell for scanning electron microscopy of three species; and Mrs H.M. Lee for supplying the manuscript of her publication on *H. ulicina* s.l.

Material in the herbaria AD, MEL and NSW, as well as selected types from BM, K and NY have been studied.

References

Bentham, G. (1870). "Flora Australiensis". Vol. 5. (Reeve: London)

Black, J.M. (1930). Additions to the flora of South Australia. No. 28. *Trans. Roy. Soc. S.Austral.* 54:59-61.

Bowler, J.M. (1982). Aridity in the late Tertiary and quaternary of Australia. In W.R. Barker & P.J.M. Greenslade (eds), Evolution of the Flora and Fauna of Arid Australia, pp. 35-45. (Peacock Publications: Adelaide).

Cleland, J.B. (1967). "Plants of Kangaroo Island." Mimeographed publication by the author.

Cleland, J.B. & Black, J.M. (1927). An enumeration of the vascular plants of Kangaroo Island. *Trans. Roy. Soc. S.Austral.* 1:24-61.

Costermans, L. (1981). "Native Trees and Shrubs of South Eastern Australia'. (Rigby: Adelaide).

Daily, B., Milnes, A.R., Twidale, C.R. & Bourne, J.A. (1979). Geology and geomorphology. In Tyler, M.J., Twidale, C.R. & J.K. King, (eds). Natural History of Kangaroo Island, pp. 2-38. (Royal Society of South Australia: Adelaide).

Eichler, H. (1965). "Supplement to J.M. Black's Flora of South Australia". (Govt. Printer: Adelaide).

Grant, V. (1971). "Plant speciation". Columbia University Press: New York.

Hamilton, A.G. (1927). The xerophytic structure of the leaf in the Australian Proteaceae. Part i. *Proc. Linn. Soc. New South Wales* 52:258-274.

Lamont, B. (1976). The *Hakea sulcata* group. *Austral. Pl.* 8:298-313.

Lee, H.M. (1984). The biology of *Hakea ulicina* R. Br. and *H. repullulans* H.M. Lee (Proteaceae). *Austral. J. Bot.* 32:679-699.

Leigh, J., Briggs, J. & Hartley, W. (1981). "Rare or Threatened Australian Plants". (Australian National Parks and Wildlife Service: Canberra).

Maconochie, J.R. (1973). Studies on some species of *Hakea* (Proteaceae). *Trans. Roy. Soc. S. Austral.* 97:127-133.

Meissner, C.F. (1854). *Hakea. Linnaea* 26:352-360.

Meissner, C.F. (1856). *Hakea. In* A.P. De Candolle (Ed.), "Prodromus Systematis Naturalis Regni Vegetabilis". Vol. 14, pp. 393-420. (Truettel & Wurtz: Paris).

Mueller, F. (1868). *Hakea.* "Fragmenta Phytographiae Australiae", vol. 6, pp. 214-220. (Govt Printer: Melbourne).

Northcote, K.H. (1960). 'Atlas of Australian Soils'. Sheet 1, Port Augusta-Adelaide-Hamilton Area. (C.S.I.R.O./ Melbourne University Press).

Wells, W.H. (1848). "A Geographical Dictionary or Gazetteer of the Australian Colonies". (W. & F. Ford: Sydney).

Willis, J.H. (1973). "A Handbook to Plants in Victoria. 2. Dicotyledons". (Melbourne University Press: Carlton).

J. Adelaide Bot. Gard. 7(3): 273-287 (1985)

STUDIES IN THE TRIBES *ASTEREAE* AND *INULEAE* (COMPOSITAE)

D. A. Cooke

State Herbarium of South Australia, Botanic Gardens, North Terrace, Adelaide 5000

Abstract

Brachycome dimorphocarpa G.L. Davis is reduced to synonymy under *B. ciliaris* (Labill.) Less., and *B. xanthocarpa* sp. nov. is described. Two sibling species, one of which is referred to *Calotis plumulifera* F. Muell., are distinguished within *C. multicaulis* sens. lat. *Olearia suffruticosa* sp. nov. and *O. pimeleoides* (DC.) Benth. subsp. *incana* subsp. nov. are described, and the new combination *O. passerinoides* (Turcz.) Benth. subsp. *glutescens* (Sonder) D.A. Cooke is made.

In the Inuleae, *Podolepis davisiana* sp. nov. is described and the new combination *P. tepperi* (F. Muell.) D.A. Cooke is made; the affinities of these species are discussed. *Scyphocoronis incurva* sp. nov. is described and compared to *S. major.*

Tribe Astereae

1. Brachycome

Brachycome ciliaris (Labill.) Less., Syn. Comp. 192 (1832). *Bellis ciliaris* Labill., Nov. Holl. Pl. Sp. 2:56 (1806).

Type: New Holland, *J. Labillardière s.n.* (Lecto: P, *n.v.*)

Brachycome dimorphocarpa G.L. Davis, Muelleria 1:112 (1959), *synon. nov.*

Type: Bon Bon Station to Kingoonya, South Australia, 11.x.1955, *N.T. Burbidge & M. Gray 4653* (Holo: CANB, *n.v.*; iso: AD!)

As described by Davis (1959), *B. dimorphocarpa* differs from *B. ciliaris* only in the inrolled wings of the disk achenes. In *B. ciliaris* the wings are usually flat but may be slightly inrolled. Out of a total of 266 collections seen, the only two specimens agreeing with the description of *B. dimorphocarpa* (cited below) with regard to the achenes, differed widely from each other in vestiture and leaf shape, and cannot be maintained as a distinct entity.

Specimens examined

SOUTH AUSTRALIA: Bon Bon Station to Kingoonya, 11.x.1955, *N.T. Burbridge & M. Gray* 4653 (AD, isotype of *B. dimorpocarpa*); 4 km SW Canopus Homestead, 19.x.1975, *L.D. Williams 7225*(AD).

Brachycome xanthocarpa D.A. Cooke, sp. nov.

Herba annua eglandulosa usque ad 12 cm alta. *Caules* erecti vel ascendentes usque ad 4 cm alti parce ramificantes, teretes rubescentes sparsim pubescentes. *Folia basilaria* oblanceolata basi attenuata 3-18 mm longa 1-5 mm lata, integra vel pinnatipartita lobis obtusis vel subacutis, supra glabra, subtus pubescentia, marcescentia. *Folia caulina* pauca, obovata vel ovata basi amplexicaulia 3-9 mm longa 1-5 mm lata sursum decrescentia, pinnatisecta segmentis acutis vel folium summum integrum, pubescentia. *Pedunculi* 2-9 erecti simplices 4-8 cm longi laeves glabri nudi, unusquisque ramum foliaceum caulis terminans. *Bracteae involucri* 9-15, obvatae vel oblanceolatae 2.3-3.2 mm longae 0.7-1.5 mm latae membranceae viridulae glabrae, ad apicem obtusae vel subacutae minute erosae plerumque purpureae. *Receptaculum* hemisphaericum vix scrobiculatum 2.0-2.5 mm diametro. *Flosculi radii* 15-27, ligulis 4-5 mm longis albis lilacinisve. *Antherae* 0.6-0.7 mm longae, connectivo loculos haud producto. *Achenia* cuneata vix complanata 1.5-1.7 mm longa c.0.6. mm lata; margines angusti haud alati laeves viriduli glabri; superficies dorsalis ventralisque depressi, tuberculis congestis grossis 0.1-0.2 mm altis ochroleucis obtecti, praeter aliquot pilos minutos prope apicem glabri. *Pappus* prominens 0.3-0.4 mm longus candidus, setis inaequalibus basi connatis. (Fig. 1).

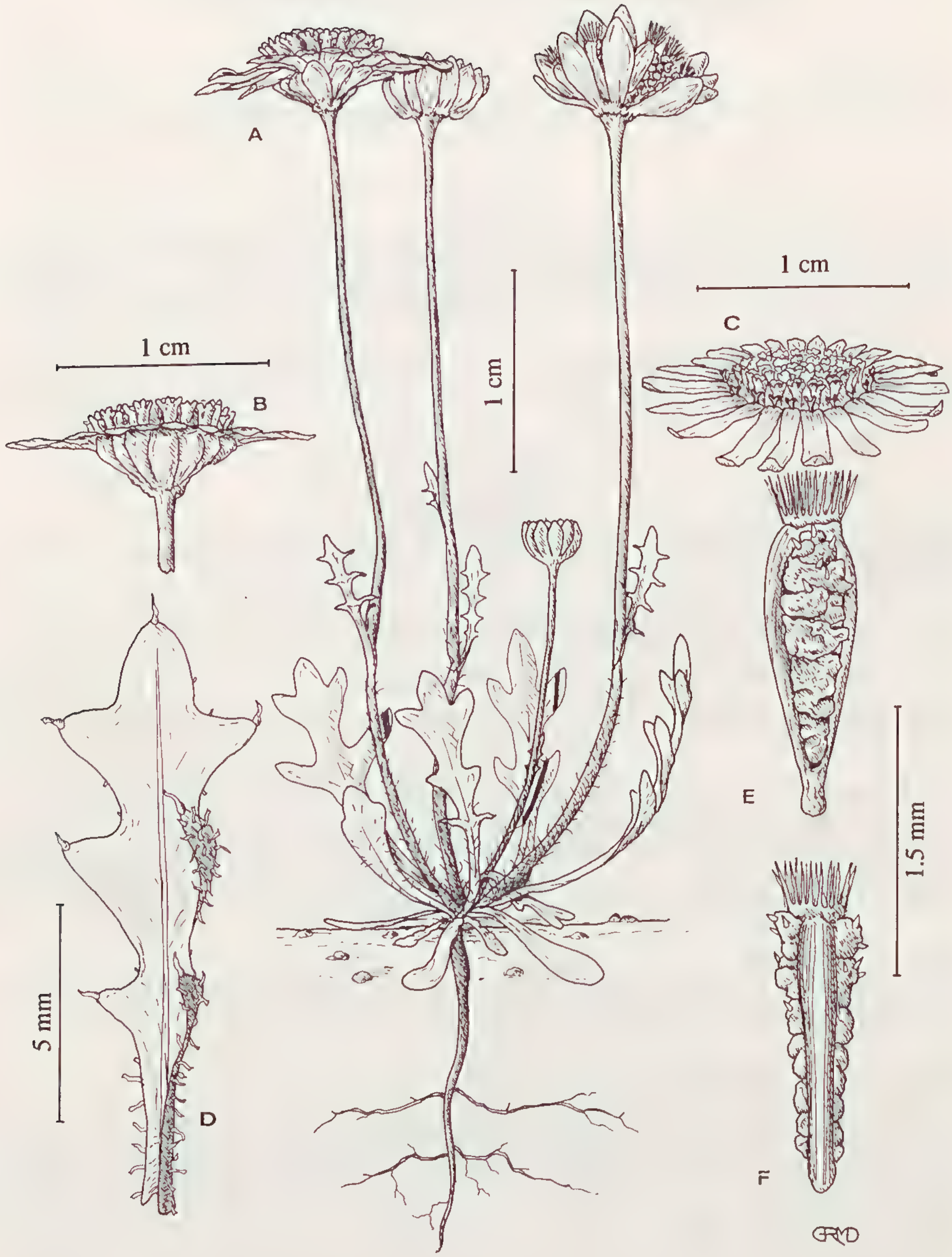


Fig. 1. *Brachycome xanthocarpa*: A, whole plant; B-C, flowering capitulum; D, basal leaf; E, achene, ventral view; F, achene, lateral view (drawn from *Wheeler 1039*, AD, holotype).

Type: Hincks National Park, Hd. of Nicholls, c.2 km E of north/south access track and c.4 km N of the southern boundary, 11.x.1968, *J.R. Wheeler 1039* (Holotype: AD 96925131).

Etymology: Greek *xanthos*, yellow; *karpos,* fruit; referring to the distinctive yellow colour of the achenes.

Annual herb, lacking glands, up to 12 cm high. *Stems* erect to ascending, up to 4 cm high, sparsely branching, terete, sparsely pubescent, becoming reddish. *Basal leaves* oblanceolate, attenuate at the base, 3-18 mm long, 1-5 mm wide, entire or pinnatipartite with obtuse to subacute lobes, glabrous on the upper surface, pubescent on the lower surface, soon withering. *Cauline leaves* few, obovate to ovate, amplexicaul at the base, 3-9 mm long, 1-5 mm wide, decreasing in size up the stem, pinnatisect with acute segments or the uppermost leaf entire, pubescent. *Peduncles* 2-9 per plant, erect, unbranched, 4-8 cm long, leafless, smooth, glabrous, each terminating a leafy branch of the stem. *Involucral bracts* 9-15, obovate to oblanceolate, 2.3-3.2 mm long, 0.7-1.5 mm wide, membranous, greenish, glabrous; apices obtuse to subacute, minutely erose, often purple. *Receptacle* hemispherical, 2.0-2.5 mm diam., hardly pitted. *Ray florets* 15-27; ligules 4-5 mm long, white to lilac. *Anthers* 0.6-0.7 mm long; connective not produced beyond the loculi. *Achenes* cuneate, hardly flattened, 1.5-1.7 mm long, c.0.6 mm wide; margins wingless, narrow, smooth, greenish, glabrous; dorsal and ventral faces depressed, covered by large crowded ochre-yellow tubercles 0.1-0.2 mm high, glabrous except for a few minute hairs near the apex. *Pappus* prominent, 0.3-0.4 mm long, white, of unequal bristles connate at the base.

B. xanthocarpa is known only from two collections from the Hincks Conservation Park, Eyre Peninsula, where it occurs in mallee scrub on sand dunes.

B. xanthocarpa is related to the other species of the genus which lack sterile anther appendages and which were grouped in the informal ' subgenus' Metabrachycome by Davis (1948). The achenes most closely resemble those of such species as *B. exilis* Sonder, *B. trachycarpa* F. Muell and the disc achenes of *B. ciliaris* which are cuneate, flattened and wingless with thick marginal ridges. In the vegetative state, *B. xanthocarpa* most closely resembles *B. exilis*, but lacks the glandular hairs characteristic of the latter species.

Specimen examined (Paratype)

SOUTH AUSTRALIA: Hincks National Park, north/south access track through Hd. of Nicholls, c. 2 km N of the southern boundary, 10.x.1968, *J.R. Wheeler 982* (AD 96924291).

2. Calotis

The name *Calotis multicaulis* has been applied to populations of annual *Calotis* which were believed to be conspecific throughout the arid zone of Australia. These were shown by Stace (1978) to consist of two species with chromosome base numbers (x) of 4 and 5 respectively. From Stace's data, populations with x=4 appeared to have a more western distribution (in W.A. and S.A.) than those with x=5 (in S.A., Qld and N.S.W.).

Analysis of herbarium collections showed populations with two distinct types of pappus awn, their distributions coinciding with those of the 'chromosomal species' recognized by Stace. In western populations the awns are minutely retrorse-barbellate, dark brown, flexible and wire-like in appearance (Fig. 2 A,B). In eastern populations the awns are plumose with spreading barbs 0.07-0.1 mm long, pallid or chestnut brown, straight and rigid (Fig. 2 C,D). No intermediate awn types were found. Examination of the voucher specimens cited by Stace showed complete correlation between the western awn type and x=4, and between the eastern awn type and x=5 in all collections with achenes.

The holotype of *C. plumulifera* F. Muell., which had been treated as a synonym of *C. multicaulis* by Black (1929), proved to be referrable to the eastern species. The nomenclature of the two sibling species is set out below, and their distribution is shown in Map 1.

Calotis multicaulis (Turcz.) Druce, Rep. Botl Soc. Exch. Club Br. Isl. 1916:611 (1917).

Goniopogon multicaule Turcz., Bull. Soc. Nat. Mosc. 24:174 (1851).

Type: W. Aust., *J. Drummond 4th collection: 115* (*n.v.*).

Calotis multicaulis, species B, sensu Stace (1978).

Selected specimens examined (collections seen: 87)

WESTERN AUSTRALIA: 27 miles SW of Tropic of Capricorn on North-west Coast Highway, 19.viii.1965, *A.C. Beauglehole 11684* (MEL); 47 miles E of Warburton Minor, 26.viii.1971, *S. Smith-White & C. Carter 8145* (CANB); 16 miles N of Leonora, 23.viii.1971, *S. Smith-White 8175* (CANB); 60 miles W of Meekatharra, 25.viii.1971, *S. Smith-White & C. Carter 8222* (CANB).

SOUTH AUSTRALIA: 24 miles N of Port Augusta, 13.viii.1966, *S.Smith-White 66/263* (CANB); Curkin Outstation, 15 km W of Mulgathing, 26.ix.1971, *J.Z. Weber 2807* (AD).

Calotis plumulifera F. Muell., J. Trans. Vic. Inst. 3:57 (1859).

Type: Darling and Murray, *F. Mueller s.n.* (Holo: MEL 104301!).

Calotis multicaulis, species A, sensu Stace (1978).

Fig. 2. A-B, *Calotis multicaulis*: A, achene; B, pappus awn (drawn from *Weber 2807*); C-D, *Calotis plumulifera*: C, achene; D, pappus awn (drawn from *Alcock 6358*). Scales: 1 mm.

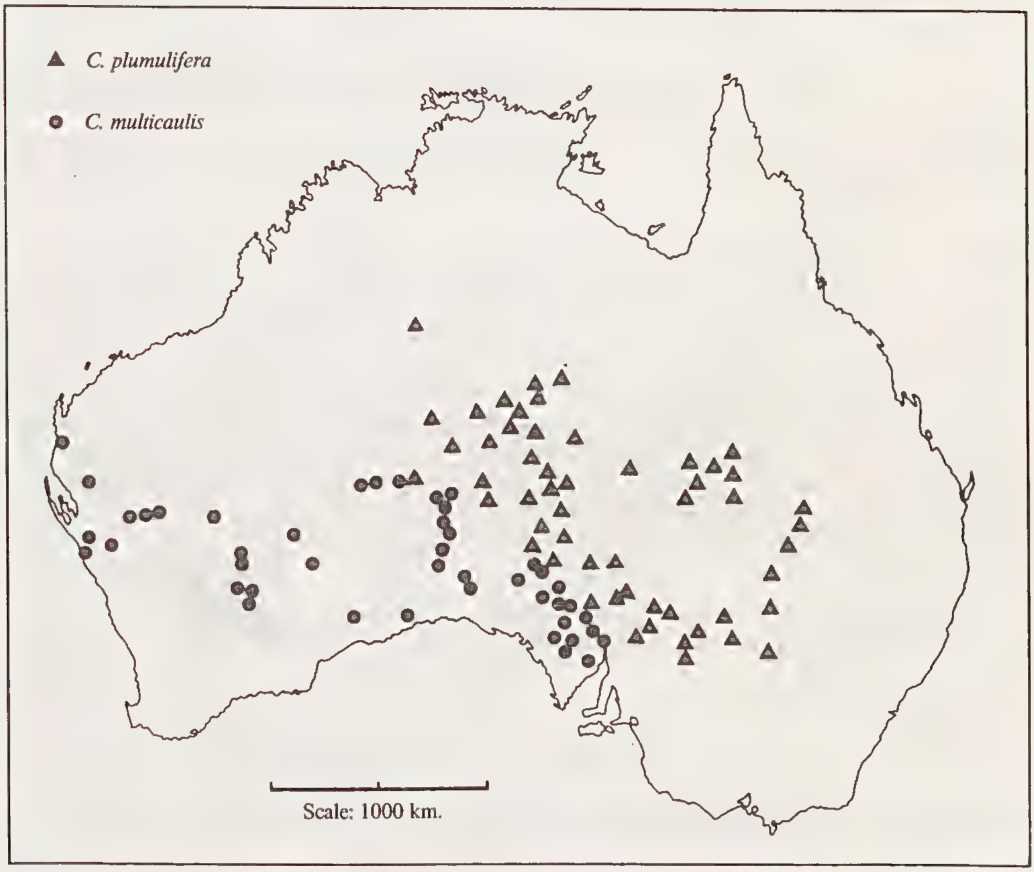
Selected specimens examined (collections seen: 180)

NORTHERN TERRITORY: c.5 km of Alice Springs, 6.vii.1968, *J.Z. Weber 863* (AD).

SOUTH AUSTRALIA: Mound Springs campsite, 26°25'S 135°30'E, 1.x.1968, *C.R. Alcock 6358* (AD); 105 miles S of Oodnadatta, 27.viii.1969, *S. Smith-White & C. Carter 4869* (CANB).

QUEENSLAND: 31 miles N of Qld border at Warri Gate, 2.ix.1971, *H.M. Stace 7703* (CANB).

NEW SOUTH WALES: 28 miles S of Broken Hill on Menindee road, 19.viii.1969, *H.M. Stace 5245* (CANB); 41 miles N of Wilcannia, 17.viii.1970, *H.M. Stace 6224* (CANB).



Map 1. Distribution of *Calotis multicaulis* and *C. plumulifera*.

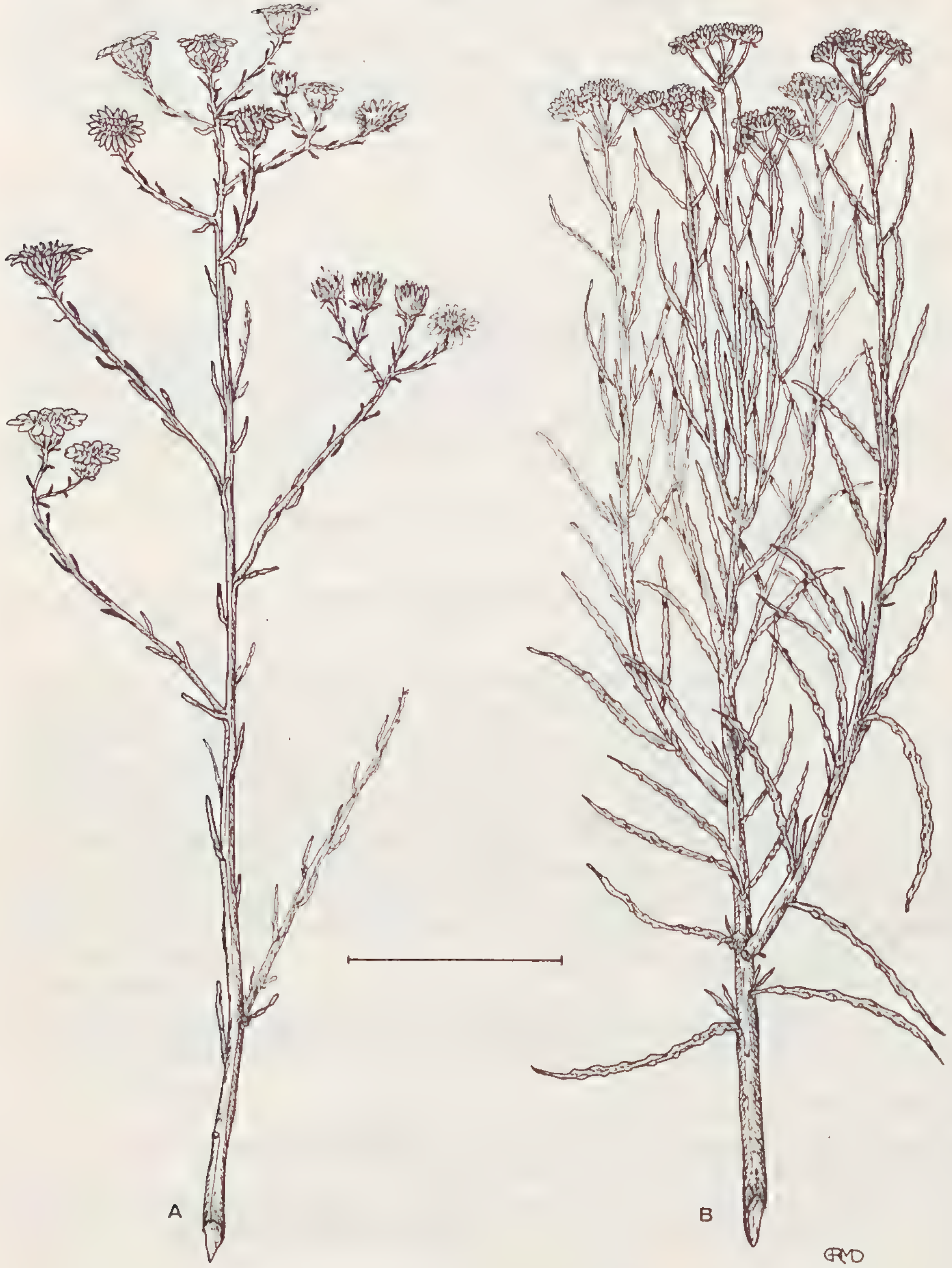


Fig. 3. A, *Olearia suffruticosa* (drawn from *Beek 44*); B, *Olearia glandulosa* (drawn from *Eichler 12198*). Scale: 5 cm.

Olearia pimeleoides (DC.) Benth., Fl. Austr. 3:479 (1867).

Eurybia pimeleoides DC., Prod. 5:268 (1836).

Type: near Peel's Range (New South Wales), 20.vi.1817, *A. Cunningham s.n.* (Holo: G, photo!).

Key to subspecies

Young stems and both surfaces of leaves lanate with grey arachnoid tomentum .... subsp. *incana*

Young stems and lower surfaces of leaves shortly pubescent with compact whitish tomentum; leaves glabrous to subglabrous above .... subsp. *pimeleoides*

subsp. **incana** D.A. Cooke, subsp. nov.

Frutex incanus, dense ramosus, 50-150 cm altus. *Ramuli* lanati tomento arachnoideo cineraceo demum glabrescentes. *Folia* in superficiebus ambabus lanata tomento arachnoideo cineraceo. *Capitula* solitaria, raro 2-3 fasciculata.

Type: c. 5 km S of Maralinga, 30.vii.1969, *B. Copley 2695* (Holotype: AD 96937169).

Etymology: Latin *incanus*, hoary; referring to the greyish foliage.

Shrub, hoary-grey, densely branched, 50-150 cm high. *Branchlets* lanate with grey arachnoid tomentum, eventually becoming glabrous. *Leaves* lanate with grey arachnoid tomentum. *Capitula* solitary or rarely in clusters of 2-3.

O. pimeleoides subsp. *incana* occurs in the Great Victoria Desert region of Western Australia and South Australia. Flowering is recorded in August and September.

Selected specimens examined (Paratypes)

WESTERN AUSTRALIA: Victoria Desert, Camp 59, 22.ix.1891, *R. Helms s.n.* (AD 96507001; AD 96926137).

SOUTH AUSTRALIA: 29°17'S 129°04'E, 7.viii.1979, *V.J. Levitzke 190* (AD 98126236); S of Mt. Beadell, 13.viii.1960, *H. Turner s.n.* (AD 96317001); 147 km W of N of Cook, 29°17'15"S 130°13'E, 19.vii.1979. *L.D. Williams 10512* (AD 98125003); near Maralinga, 18.ix.1960, *P. Wilson 1745* (AD 96138003).

The subspecies *incana* appears to be parapatric with the typical subspecies at the south-eastern edge of its range, which is almost entirely through more arid habitats than the range of subsp. *pimeleoides*.

TRIBE INULEAE

4. Podolepis

Podolepis muelleri (Sonder) Davis, occurring in N.S.W. and South Australia, was differentiated from the Western Australian *P. lessonii* (Cass.) Benth. by Davis (1957). Study of South Australian material formerly determined as *P. muelleri* has demonstrated the existence of the related inland species described here.

Podolepis davisiana D.A. Cooke, sp. nov.

Herba annua, 8-16 cm alta, subincana vestimento araneoso eglanduloso. *Caules* ascendentes, parce ramificantes, teretes, brunneo-vinosi, sparsim arachnoidei apprime prope nodos. *Folia basilaria* pauca, elliptica vel oblanceolata, 1-4 cm longa, arachnoidea, marcescentia. *Folia caulina* lanceolata vel elliptica, basi amplexicaulia, apice acuta, 1-4 cm longa, 3-8 mm lata, margine aliquanto revoluta, super arachnoidea vel lanata, subtus densiore lanata. *Capitula* homogama, pedunculata, 1-3 in bostryche laxo folioso ramum unoquoque terminante. *Pedunculus* capillaris, 1-4 cm

longus, subglabrus, brunneo-vinosus, filo cupreo similis. *Involucrum* hemisphaericum, 8-10 mm diametro, bracteis quasi sexfariis. Laminae bractearum late ovatae, acutae, scariosae, laeves vel leviter caperatae, stramineae, prope apicibus saepe plusminusve aerugino-tinctae. Bracteae extimae brevissime, laminis integris sessilibus; serierum intermediarum usque ad 5 mm longae, laminis magnioribus plusminusve ciliatis, in stereomatibus incurvatis successive longioribus herbaceis glandulosis; intimae c. 4 mm longae, non nisi ad basim adhaerentes, stereomatibus spathulatis basi dilatatis herbaceis glandulosis, scarioso-hyalinae marginatae. *Receptaculum* planum, nudum, scrobiculatum. *Flosculi* 40-90, omnes similares, bisexuales, fertiles, involucrum excedentes, exteriores deflexi impendentes. *Corolla* tubularis, flava; tubus anguste cylindricus, 2.5-3 mm longus; lobi 5, lanceolati, patentes, marginibus incrassatis in sicco fuscatis. *Antherae* 5, subperfecte exsertae, c. 1.4 mm longae cum apicibus lanceolatis sterilibus c. 0.4 mm longis. *Achaenium* ellipsoideum vix compressum, c. 1.5 mm longum cum fundo angustato 0.25 mm longo, 0.4 mm latum, sparsim papillatum, brunneum. *Setae pappi* 9-14, uniseriales, equales, 2-2.6 mm longae, subplumosae, albidae, brevissime connatae annulum formantes. (Descriptio typi.) (Fig. 5).

Type: western edge of Lake Torrens, c. 3 km N of South Gap Station Homestead, 3.ix.1968, *R. Swinbourne 19* (Holotype: AD 96929450; isotype: MEL).

Etymology: Named after Professor Gwenda L. Davis, who first revised *Podolepis* and several other genera of Australian Compositae.

Annual herb 8-16 cm high, almost hoary with an arachnoid non-glandular vestiture. *Stems* ascending, sparsely branched, terete, brown-vinaceous, sparsely arachnose especially near the nodes. *Basal leaves* few, elliptic to oblanceolate, 1-4 cm long, arachnose soon withering. *Cauline leaves* lanceolate to elliptic, amplexicaul at the base, acute, 1-4 cm long, [illegible]-8 mm wide, somewhat recurved at the margins, archnose to lanate above, more densely lanate below. *Capitula* homogamous, pedunculate, 1-3 in a leafy bostryx terminating each branch. *Peduncle* capillary, 1-4 cm long, subglabrous, brown-vinaceous, resembling copper wire. *Involucre* hemispherical, 8-10 mm diam., with bracts in about 6 series. Bract laminae broadly ovate, acute, scarious, smooth or slightly wrinkled, stramineous, often somewhat blue-green tinted near the apex. Outermost bracts very short with entire sessile laminae; intermediate bracts up to 5 mm long with larger more or less ciliate laminae on successively longer herbaceous glandular incurved stereomes; innermost bracts c. 4 mm long, adhering at the bases only, with herbaceous scarious-hyaline margined glandular spathulate stereomes dilated at the base. *Receptacle* flat, naked, pitted. *Florets* 40-90, all similar, bisexual, fertile, exceeding the involucre, the outer ones deflexed and overhanging. *Corolla* tubular, yellow; tube narrowly cylindric, 2.5-3 mm long; lobes 5, lanceolate, patent, with thickened margins darkening when dried. *Anthers* 5, almost fully exserted, c. 1.4 mm long including the sterile lanceolate apices c. 0.4 mm long. *Achene* ellipsoid, slightly compressed, c. 1.5 mm long including a narrowed base 0.25 mm long, 0.4 mm wide, sparsely papillose, brown. *Pappus bristles* 9-14, uniseriate, equal, 2-2.6 mm long, subplumose, whitish, very shortly connate to form a ring at the base.

P. davisiana occurs in the Lake Eyre Basin, Gairdner-Torrens Basin and northern Flinders Ranges regions of South Australia. This distribution does not overlap that of *P. lessonii* (in Western Australia west of about 124°E), or of *P. muelleri* (restricted in South Australia to the southern Flinders Ranges and coastal cliffs of the Southern Lofty region). Habitat is on stony slopes and gibber plains. Flowering is recorded in August and September.

Specimens examined

SOUTH AUSTRALIA: Hills overlooking Lake Torrens, 5.ix.1968, *S. Barker 233* (AD 96842043); Christensen Place, Andamooka. 23.viii.1978, *E. Brown s.n.* (AD 97843444); c. 2 km W of Pimba, 7.ix.1966, *N.N. Donner 1677* (AD 96834406); The Crab Holes, Pimba, viii.1947, *A.R.R. Higginson s.n.* (AD 97233241); Mt Barry Station, 13.ix.1951, *E.H. Ising s.n.* (AD 96507171); 12 miles W of Mt Barry Station, 12.ix.1955, *E.H. Ising 3829* (AD 96507187); Mt Lyndhurst, viii.1899, *M. Koch 217* (AD 97631663; AD 97631665); c. 20 km W of Pimba, 2.viii.1963, *R.H. Kuchel 539* (AD 96344019); N of Lake Hanson Dam, Wirramina Station, ref. 435125 Kingoonya, 12.viii.1971, *B. Lay 371* (AD 97149215); 5 miles N of Duff Creek, 7.viii.1963, *T.R.N. Lothian 1354* (AD 96338055; MEL); Warrina, 31.vii.1968, *T.R.N. Lothian 4918* (AD 96845292).

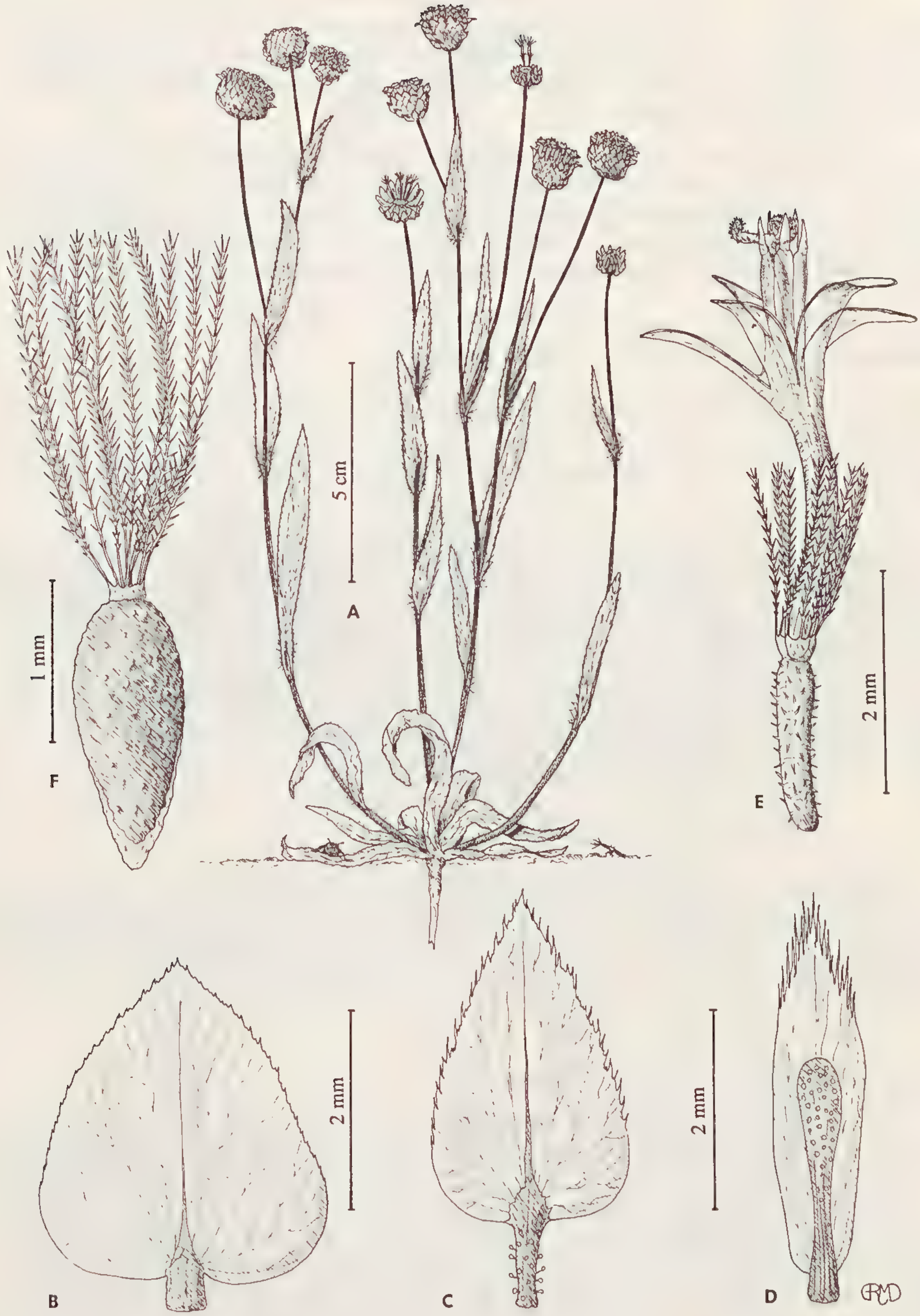


Fig. 4. *Podolepis davisiana*: A, whole plant; B, outer bract; C, intermediate bract; D, inner bract showing the stereome dilated at base only; E, floret; F, achene (drawn from holotype).

P. davisiana is closely related to *P. lessonii* and *P. muelleri*, both of which are annuals with wiry stems, amplexicaul leaves, small discoid capitula on long naked peduncles, and broad, membranous involucral bracts. In both these species the outer florets are female, with 3 or 4 corolla lobes and a variously reduced pappus; thus, *P. davisiana* is unique in the genus in having homogamous capitula.

The stereomes of the innermost series of involucral bracts are also of diagnostic importance in these species. In *P. lessonii* they are narrowly oblanceolate, completely free and surrounded by membranous margins; in *P. muelleri* they are broadly oblong, fused for about half their length and greatly thickened to form a cup around the florets. The condition in *P. davisiana* is between these extremes, with the stereomes adhering at the base only.

Podolepis tepperi (F. Muell.) D.A. Cooke, comb. nov.

Helichrysum tepperi F. Muell., *Wing's Southern Science Record* 2:1 (1882).

Type: Mulloowurtie, Yorke Peninsula, South Australia, 28.ix.1880, *J.G.O. Tepper 79* (Holo: MEL!).

Podolepis tepperi is a small, short-lived annual or ephemeral of poor soils, apparently an inbreeder on the evidence of the low pollen-ovule ratio (Short, 1981), and consequently has capitula and florets which are reduced in structure and inconspicuous. Mueller (1882) placed it in *Helichrysum* on the basis of the narrow, shortly lobed corollas and the almost filiform female florets. However, *P. tepperi* closely resembles the three species discussed above in habit, vestiture, leaf form and involucre. It appears to be more appropriately treated as a reduced *Podolepis* related to these species and more distantly to *P. capillaris* (Steetz) Diels than as an anomalous *Helichrysum*.

5. Scyphocoronis

This genus has been regarded as monotypic, with the species *S. major* (Turcz.) Druce occurring in Western Australia and South Australia. Schodde (1963) referred two anomalous specimens from the far north-west of South Australia to an undescribed taxon of uncertain affinities; further collections have made it possible to describe this taxon as a species of *Scyphocoronis*.

Scyphocoronis incurva D.A. Cooke, sp. nov.

Herba annua, 2-8 cm alta, vestimento brevissimo viscido. *Caules* plerumque e basi aliquot, ascendentes ramis brevibus erectis vel suberectis, teretes, glanduloso-pubescentes. *Folia basilaria* pauca, linearia, unumquidque caulem subtendens, marcescentia. *Folia caulina* alterna vel inferiora subopposita, erecta, linearia vel oblanceolata, subacuta, 3.5-22 mm longa, 0.7-1.2 mm lata, margine integra, utrinque virida glanduloso-pubescentia. *Capitula* homogama, pedunculata, terminalia, solitaria. *Pedunculus* erectus, (4)-7-24 mm longus, pubescens et pilis glandulosis brevissimus et pilis eglandulosis laxis longioribus. *Involucrum* cyathiforme, 3-4 mm longum. Bracteae 6-8-(10), unifariis, aequales, non nisi ad basim connatae vel subdiscretae, ellipticae vel oblanceolatae, herbaceae, dense glandulosae, apicibus acutis scarioso-hyalinis. *Receptaculum* planum, nudum, scrobiculatum. *Flosculi* 10-20, omnes similares, bisexuales, fertiles, involucrum excedentes, exteriores deflexi. *Corolla* tubularis, flava; tubus 2-2.4 mm longus, inferne anguste cylindricus et parce glandulosus, superne infundibuliformis; lobi 5, acuti, aequales, patentes, 0.7-0.8 mm longi. *Antherae* 5, c. 1.25 mm longae cum apicibus lanceolatis sterilibus 0.25 mm longis. *Rami styli* lineares apicibus dilatatis papillosis. *Achenium* anguste cylindricum, basi truncatum, c. 3 mm longum, inferne c. 0.5 mm diam., superne abrupte dilatatum cupulam 0.5 mm longam 0.7-0.9 mm diam. margine incurvo integro formans, laeve, parce glandulosum, nigrum. *Pappus* absens. (Fig. 5).

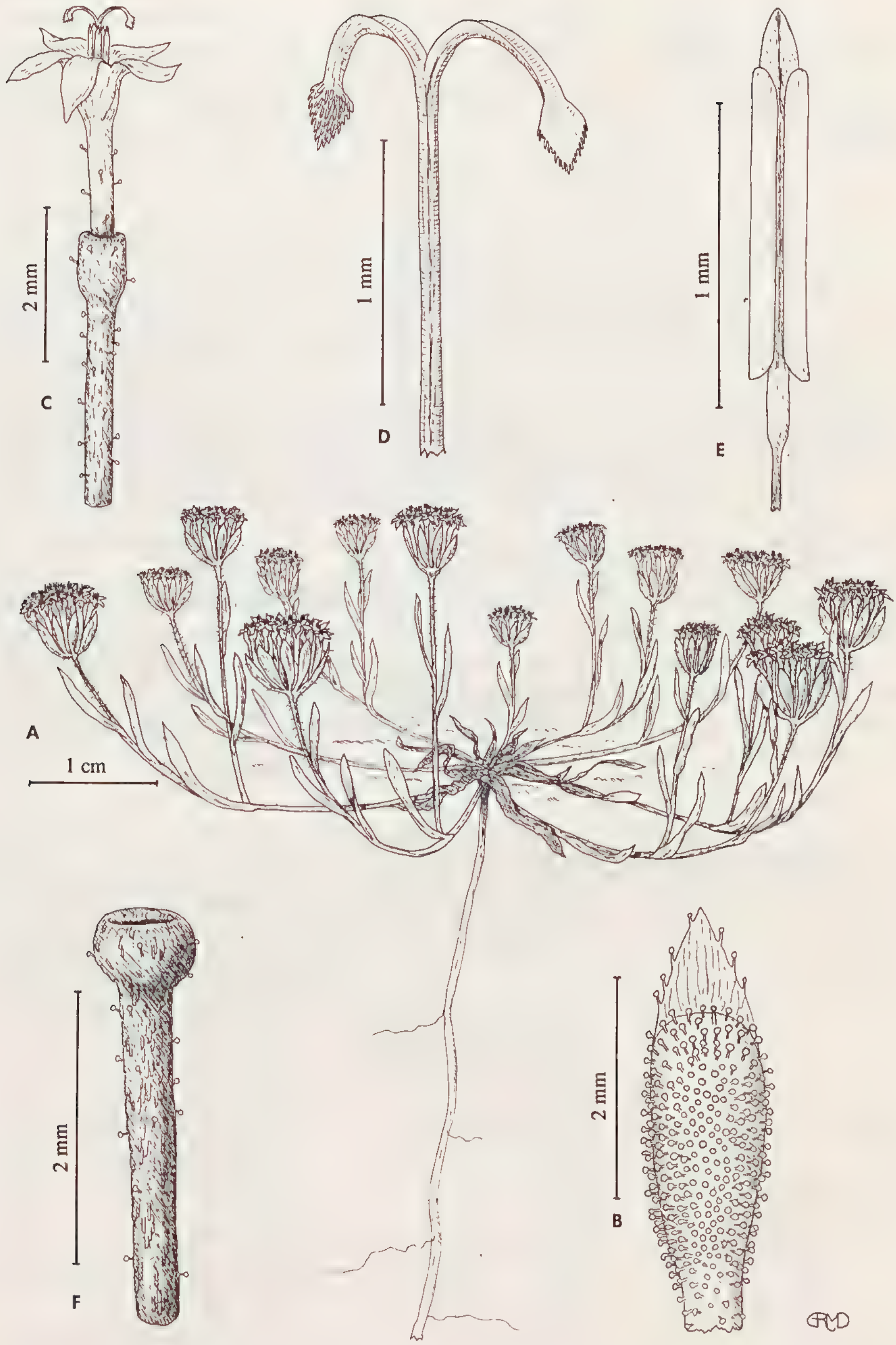


Fig. 5. *Scyphocoronis incurva*: A, whole plant; B, bract; C, floret; D, style; E, anther; F, achene (drawn from holotype).

Type: "Unnamed Conservation Park", NW portion, just E of S.A. and W.A. border and W of Serpentine Lakes, along the track, 28°32′S 129°00′E, 25.viii.1980, *J.Z. Weber 6461* (Holotype: AD 98040027).

Etymology: Botanical Latin *incurvus*, incurved, referring to the rim of the cup surmounting the achene.

Annual herb 2-8 cm high, with very short viscid vestiture. *Stems* usually several from the base, ascending with short erect or suberect branches, terete, glandular-pubescent. *Basal leaves* few, linear, each subtending a stem, soon withering. *Cauline leaves* alternate or the lower ones subopposite, erect, linear or oblanceolate, subacute, 3.5-22 mm long, 0.7-1.2 mm wide, with an entire margin, green and glandular-pubescent on both surfaces. *Capitula* homogamous, pedunculate, terminal, solitary. *Peduncle* erect, (4)-7-24 mm long, pubescent with very short glandular hairs and longer lax non-glandular hairs. *Involucre* cyathiform, 3-4 mm long. Bracts 6-8-(10), uniseriate, equal, connate at the base only or almost free, elliptic or oblanceolate, herbaceous, densely glandular, with acute scarious-hyaline apices. *Receptacle* flat, naked, pitted. *Florets* 10-20, all similar, bisexual, fertile, exceeding the involucre, the outer ones deflexed. *Corolla* tubular, yellow; tube 2-2.4 mm long, narrowly cylindric and sparsely glandular below, infundibuliform above; lobes 5, acute, equal, patent, 0.7-0.8 mm long. *Anthers* 5, c. 1.25 mm long including the sterile lanceolate apices 0.25 mm long. *Style branches* linear with dilated papillose apices. *Achenes* narrowly cylindric, truncate at the base, c. 3 mm long, 0.5 mm diam. below, abruptly dilated above to form a cup 0.5 mm long, 0.7-0.9 mm diam. with an entire incurved rim, smooth, sparsely glandular, black. *Pappus* absent.

S. incurva occurs from the Cosmo Newberry area of Western Australia through the Great Victoria Desert into the Northwestern region of South Australia; the range does not overlap that of *S. major.* Habitat is on sand dunes and inter-dune swales. Flowering is recorded from July to September.

Table 1. Comparison of *S. incurva* and *S. major*

	S. incurva	S. major
Habit	loosely spreading	compact
Peduncle length	(4-)7-24 mm	1.7 mm
Peduncle vestiture	short glandular hairs exceeded by arachnoid nonglandular hairs	short glandular hairs only
Bract number	6-8(-10)	3-8
Bract shape	elliptic to oblanceolate	linear to narrowly elliptic
Florets	all 5-merous	4-merous and 5-merous
Corolla tube length	2-2.4 mm	1-1.6 mm
Corolla lobe length	0.7-0.8 mm	0.2-0.3 mm
Anther cell length	c. 1 mm	c. 0.3 mm
Anther appendage length	c. 0.25 mm	c. 0.1 mm
Achene cup rim	entire, incurved	irregularly toothed or jagged, erect

Specimens examined

WESTERN AUSTRALIA: 32 km ENE of Cosmo Newberry, 1.ix.1973, *R.J. Chinnock 686* (AD 97343202).

SOUTH AUSTRALIA: Camp 22 (Elder Exploring Expedition), 16.vii.1891, *R. Helms s.n.* (AD 95732062; AD 96923020); Cook-Vokes Hill road 1 km S of Camp 2, Great Victoria Desert, 19.viii.1980, *G. Jackson 1247* (AD 98048098); Seismic line running N from Vokes-Serpentine road, Great Victoria Desert, 28°33′S 130°41′E, 22.viii.1980, *G. Jackson 1419* (AD 98048029); c. 130 km N of Cook along track, Cook-Vokes corner, 29°36′S 130°08′E, 19.viii.1980, *J.Z. Weber 6330* (AD 98037029); 7.84 km E of W.A. border on track from Serpentine Lakes, 28°30′15″S 129°04′45″E, 29.vii.1979, *L.D. Williams 10699* (AD 98125042).

Most of the specimens cited above had previously been determined as *Millotia greevesii* F. Muell. var. *helmsii* (F. Muell. & Tate) Schodde, which is readily distinguished from *Scyphocoronis* by the white lanose vestiture, the presence of a small pappus and the absence of a cup on the achene.

The most notable morphological differences between *Scyphocoronis incurva* and *S. major* are summarised in Table 1.

Specimens of *S. major* used in comparison

SOUTH AUSTRALIA: c. 7 km NE of Daly Head, 13.x.1968, *W.R. Barker 641* (AD 96927226); c. 0.75 km NW of Bascombe Well Homestead, 8.x.1967, *Hj. Eichler 19350* (AD 96825179); Point Sinclair, 16.ix.1971, *Hj. Eichler 21366* (AD 98242425); Hincks National Park, 10.x.1968, *J.R. Wheeler 981* (AD 96924290).

Acknowledgements

I would like to thank Mr Gilbert R.M. Dashorst for preparing the five illustrations, and also the Directors of CANB and MEL herbaria for the loan of specimens.

References

Bentham, G. (1867). "Flora Australiensis". Vol. 3 (Reeve: London).

Black, J.M. (1929). "Flora of South Australia". 1st edn. Vol. 4. (Govt Printer: Adelaide).

Davis, G.L. (1948). Revision of the genus *Brachycome* Cass. Part 1. Australian species. *Proc. Linn. Soc. N.S.W.* 73:142-241.

Davis, G.L. (1957). Revision of the genus *Podolepis* Labill. *Proc. Linn. Soc. N.S.W.* 81:245-286.

Davis, G.L. (1959). Two new Australian species of *Brachycome* Cass. (Compositae). *Muelleria* 1:111-113.

Mueller, F. (1882). Australian Plants—(New or imperfectly known). *Wing's Southern Science Record* 2:1-2.

Schodde, R. (1963). A taxonomic revision of the genus *Millotia* Cass. (Compositae). *Trans. R. Soc. S. Aust.* 87:209-241.

Short, P.S. (1981). Pollen-ovule ratios, breeding systems and distribution patterns of some Australian Gnaphaliinae (Compositae: Inuleae). *Muelleria* 4:395-417.

Stace, H.M. (1978). Cytoevolution in the genus *Calotis* R. Br. (Compositae: Astereae). *Aust. J. Bot.* 26:287-307.

Willis, J.H. (1956). Systematic notes on Victorian Compositae—1. *Muelleria* 1:24-33.

J. Adelaide Bot. Gard. 7(3): 289-293 (1985)

STUDIES IN *SENECIO* (COMPOSITAE)

M.E. Lawrence

CSIRO, Division of Horticultural Research, GPO Box 350, Adelaide 5001

Abstract

Senecio odoratus Hornem. var. *longifolius* var. nov. and *S. cunninghamii* DC. var. *serratus* var. nov. are described, and a key to all varieties of these related species provided. *S. georgianus* DC. var. *latifolius* J.M. Black and *S. minimus* Poir. var. *picridioides* (Turcz.) R.O. Belcher are recognised at the specific level as *S. gawlerensis* nom. nov. and *S. picridioides* (Turcz.) M.E. Lawrence comb. nov. respectively.

Key to *Senecio odoratus*, *S. cunninghamii* and their varieties

1. Venation of leaves intricately reticulate, adaxially impressed, abaxially raised and usually darkening on drying; leaves dark green above or glaucous, glabrous or sparsely arachnoid below, usually broadly auriculate .... *S. odoratus*
   2. Cauline leaves at least twice as long as broad.
      3. Cauline leaves 3-7 times longer than broad, rarely approaching 2 or 10 times longer than broad, oblanceolate with stem-clasping auricles, glaucous (Fig. 1A) .... var. *odoratus*
      3. Cauline leaves at least 10 times longer than broad, linear or narrowly lanceolate, with or without minute auricles, dark green above, lighter below (Fig. 1B) .... var. *longifolius*
   2. Cauline leaves less than twice as long as broad, obovate with stem-clasping auricles, glaucous (Fig. 1C) .... var. *obtusifolius*
1. Venation of leaves not conspicuous, laterals sometimes evident on drying and then not usually darkened; leaves green or becoming glaucous, glabrous or at least the young shoots and often the involucres with a fine white tomentum, leaves with or without small toothed auricules .... *S. cunninghamii*
   4. Cauline leaves linear to narrowly lanceolate, entire or shortly and distantly toothed, green; glabrous plants (Fig. 1D) .... var. *cunninghamii*
   4. Cauline leaves oblanceolate, serrate, green or becoming glaucous; at least the young shoots and often the involucres white-tomentose (Fig. 1E) .... var. *serratus*

Senecio odoratus Hornem., Hort. Hafn. 2:809 (1815)

Type: Presumably a specimen grown in botanic garden at Copenhagen from achenes sent from England.

var. **longifolius** M.E. Lawrence, var. nov.

Suffrutex ad 150 cm altum. *Folia* anguste lanceolata, saltem 10-plo longiora quam latiora (5-14 x 0.5-1.4 cm), basi agustata vel subpetiolata, cum vel sine auriculis dentatis parvis, margine saepe plana, interdum breviter revoluta, remote denticulata vel subintegra, pagina adaxiali perviridi, pagina abaxiali dilutiore dilute or dilutiore viridi diluta, venis reticulatis conspicuis atrantibus ubi desiccatis. *Inflorescentia* plerumque paniculata aliquantum laxa, interdum corymbosa.

Type: Ravine des Casoars, 2.ii.1948, *J.B. Cleland* (Holotype: AD 97245349, isotype: AD 97410421).

Etymology: Latin *longi-*, long; *-folius*, leaved; referring to the leaves much longer than broad.

Subshrub to 150 cm high. *Leaves* narrowly lanceolate, at least 10 times longer than broad, 5-14 x 0.5-1.4 cm, basally narrowed or subpetiolate, with or without small toothed

auricles, margins often flat, sometimes shortly revolute, distantly and minutely toothed or subentire, adaxially dark green, abaxially lighter with conspicuous veins that usually darken on drying, glabrous or sparsely arachnoid. *Inflorescence* usually paniculate and rather lax, sometimes corymbose. (Fig. 1B).

S. odoratus var. *longifolius* is known to occur in South Australia only on the western end of Kangaroo Island in the Ravine des Casoars and in the vicinity of the Rocky River, and on Pearson Island. Flowering occurs from November to March.

Selected specimens examined (collections seen: 25)

SOUTH AUSTRALIA. Kangaroo Island: Ravine des Casoars, 15.i.1983, *G. Jackson 1578* (AD 98309017); banks of the Rocky River at the Koala Bear Sanctuary, 27.xii.1957, *R. Schodde 516* (AD 96024071). Pearson Island: North Bay, Pearson Island, 6.i.1969, *D. Symon 6603* (AD 97544530); North Pearson Island, 14.ii.1960, *R.L. Specht* (AD 966071063).

An uncommon narrow-leafed variety bearing some resemblance in foliage and inflorescence to *S. cunninghamii* var. *cunninghamii* but distinguished from the latter and allied to *S. odoratus* by its prominent reticulate leaf venation and, when present, sparse arachnoid pubescence on the lower leaf surface. Care should be used in interpreting small sprigs of *S. odoratus* only a few cm long, as leaves of the typical variety are frequently reduced and almost linear on axillary shoots towards the inflorescence but larger and oblanceolate or obovate on the older stems.

Fig. 1. Flowering branches of A, *Senecio odoratus* var. *odoratus* (*Eichler 15477*); B,—var. *longifolius* (*Cleland AD 97245349*; holotype); C,—var. *obtusifolius* (*Lawrence 610*); D, *S. cunninghamii* var. *cunninghamii* (*Cleland AD 97245383*); E,—var. *serratus* (*Cunningham s.n.*; holotype). (All x ½).

Senecio cunninghamii DC., Prodr. 6:371 (1838), as cunninghami.

Type: *Cunningham* (Holotype: G); Prodromus Herbarium, vi.371 no. 164; a specimen of unknown provenance, which, according to the note attached, was received by Candolle admixed with *Cunningham 130*, the type of *S. georgianus*; photo seen.

S. brachylaenus DC., Prodr. vi:370 no. 163 (1838).

Type: Banks of the Lachlan River, *Cunningham 142*, vi.1817 (Holotype: G-DC; photo seen).

var. **serratus** M.E. Lawrence, var. nov.

S. cunninghamii sensu Benth., Fl. Austral. 3:671 (1866), *pro parte*; sensu Black, Fl. S. Austral. 613 (1929), *pro parte*: *non* DC., Prodr. 6:371 (1838).

S. cunninghamii form 2 (arid zone) M.E. Lawrence, Aust. J. Bot. 28:154 (1980).

S. sp. (aff. *S. cunninghamii*) G.M. Cunn. *et. al.*, Pl. West. N.S.W. 675, text and fig. (1981); M.E. Lawrence, Fl. Cent. Austral. 385 (1981).

S. sp. F (aff. *S. cunninghamii*) Jacobs and Pickard, Pl. N.S.W., Census 86 (1981), cited as in Northern Far Western Plains.

Suffrutex ad 100 cm altum, saltem partibus juvenilibus et saepe involucris cum tomento tenui albo cristato. *Folia* oblanceolata, serrata, serraturae saepe serrulatae, attenuata vel subpetiolata cum vel sine auriculis parvis denticulatis, tomentosa, demum glabrata. *Phyllaria* 3-4 mm long.

Type: S. Aust. Chintapanna Dam, Witchelina Station, 13.iii.1979, *F. Badman 182* (Holotype: AD 97927194, isotypes: COLO, G, HO).

Etymology: Latin *serratus*, serrate; referring to the saw-like teeth of the leaf margins.

Subshrub to 100 cm high, at least the youngest shoots and often the involucres with a fine white tomentum of crisped hairs. *Leaves* oblanceolate, serrate, the teeth sometimes again shortly toothed, basally narrowed or subpetiolate, with or without small toothed auricles, tomentose, becoming glabrate. *Phyllaries* 3-4 mm long. (Fig. 1E).

S. cunninghamii var. *serratus* is confined to central Australia, occurring in southern regions of the Northern Territory, the south-western corner of Queensland, north-western New South Wales, and north-central and north-eastern regions of South Australia. It is most frequent near areas of temporary impeded drainage on sand or clay, and less frequent on hillsides or open stony plains. Flowering occurs opportunistically throughout the year, with peaks recorded in September and May.

Selected specimens examined (collections seen: 122)

NORTHERN TERRITORY: Finke River, S. Glen Helen H.S., 4.ii.1955, *G. Chippendale* (AD 95910081); 1 mile N of Alice Springs, 12.xi.1963, *R. Swinbourne 774* (AD 96535160).

SOUTH AUSTRALIA: Maree-Dulkaninna track 5 miles from Maree, 23.ix.1956, *T.R.N. Lothian L2001* (AD 96224209); Mulgaria H.S. 30°14'S 137°38'E, 13.xii.1964, *P. Aitken* (AD 96506008); Roadside near Avondale on Talc Road from Lyndhurst, 4.iii.1966, *D.E. Symon 4044* (AD 97544259).

QUEENSLAND: Wilson River, ix.1922, *Dr McGillivray 903* (AD 97630543, no. 1 of 3 specimens, Herb. J.M. Black).

NEW SOUTH WALES: Mt Mulyah c. 50 miles NW Louth, vi.1968, *E.D. Arnay* (CANB 188080); Mt King Station near Tibooburra, 11.ix.1971, *Perry 5814* (CANB 254469).

Var. *serratus* differs from var. *cunninghamii* in both morphology and distribution; var. *serratus* has serrate leaves, a white tomentum on at least the young shoots, and occurs in central Australia; var. *cunninghamii* is a glabrous plant with entire leaves that occurs predominantly in the Murray-Darling drainage system. Occasional plants of somewhat intermediate morphology occur in the southern Flinders Ranges and northern Lofty regions of South Australia. They have short revolute entire leaves characteristic of rare collections of var. *cunninghamii* from Yorke Peninsula, and a white tomentum on the youngest shoots indicative of var. *serratus*.

Senecio picridioides (Turcz.) M.E. Lawrence, comb. nov.

Type: W. Aust., Swan River, *J. Drummond, 3rd collection: 132* (Isotypes: K, FI), *n.v.*

Erechtites picridioides Turcz. Bull. Soc. Imp. Nat. Mosc. 24:200 (1851); Black, Fl. S. Austral. 4:610 (1929). —*non* Sond. and F. Muell, ex Sonder, Linnaea 25:523 (1852) = *S. runcinifolius*.

E. prenanthoides DC. var. *picridioides* (Turcz.) Benth., Fl. Austral. 3:658 (1866).

S. minimus Poir. var. *picridioides* (Turcz.) R.O. Belcher, Ann. Mo. Bot. Gdn. 43:48 (1956).

S. minimus Robertson in Fl. S. Austral. 4:887 (1965) *pro parte, non* Poir. Lam. Ency. Meth. Bot. Suppl. 5:130 (1817).

Erechtites picridioides Turcz. was treated as a variety of *E. prenanthoides* by Bentham (1866) and as a variety of *Senecio minimus* by Belcher (1956). The treatment is inconsistent when compared with other varieties and species of *Senecio*. The lobed leaves and hispid vestiture of var. *picridioides* are quite different from those of var. *minimus* and the characteristic purple pigmentation of the leaves and stems of var. *picridioides* is approached only by *Arrhenechtites mixta* (A. Rich.) Belcher in the Senecioneae of Australia. The floral morphology of var. *picridioides* and var. *minimus* is similar, but on this ground alone, *S. bipinnatisectus* Belcher and perhaps also *S. biserratus* Belcher should have been treated as varieties of *S. minimus*. *S. minimus* var. *picridioides* is accordingly recognised at the specific level, as it was by Black (1929) in *Erechtites*. He likened it to his *E. prenanthoides*, which, as shown by Belcher (1956), is actually *Senecio biserratus* Belcher. Robertson compounded Black's error by reducing *E. picridioides* to a synonym of her *S. minimus*, which is partly *S. biserratus*, partly *S. picridioides*.

Senecio gawlerensis M.E. Lawrence, nom. et stat. nov.

Type: 10 miles W. Yardea, E.P., 24.viii.1928, *J.B. Cleland* (Lectotype selected here: AD 96822076!). Caroona, E.P., s. date, Dr W.L. Cleland (Syntype: AD 96822072!).

S. georgianus DC. var. *latifolius* J.M. Black, Fl. S. Austral. 613 (1929).

Black (1929) probably treated material from the Gawler Ranges as a variety of *S. georgianus* because the latter is the only discoid species with a high floret number (35-40) reported to occur in South Australia. The floret number of *S. gawlerensis* (15-20) is higher than in other South Australian discoid species (9-14) but is numerically closer to these than to *S. georgianus*. Furthermore, the leaves of *S. georgianus* are linear or lanceolate, entire or shortly toothed and arachnoid beneath at maturity, while those of *S. gawlerensis* are broad-lanceolate or ovate, deeply toothed or pinnatifid and glabrate at maturity. As the epithet *latifolius* has been used several times at the specific level in *Senecio*, the epithet *gawlerensis* was selected to reflect the restricted distribution of this species in the Gawler Ranges of South Australia. The J.B. Cleland specimen was chosen as lectotype as it has Black's notes and drawings.

Acknowledgements

I would like thank Dr R.O. Belcher for helpful discussions, assistance with Latin diagnoses and the location of type material in Europe, Mr G.R.M. Dashorst for the illustrations, the directors of NSW, CANB and MEL herbaria for the loan of specimens and the State Herbarium of South Australia for the use of facilities during the preparation of this manuscript.

References

Belcher, R.O. (1956). A revision of the genus Erechtites (Compositae), with inquiries into *Senecio* and *Arrhenechtites*. *Ann. Mo. Bot. Gard.* 43, 1-85.

Bentham, G. (1867). "Flora Australiensis". Vol. 3 (Reeve: London).

Black, J.M. (1929). "Flora of South Australia". 1st edn Vol. 4. (Govt Printer: Adelaide).

Lawrence, M.E. (1981). *Senecio. In* J.P. Jessop et al. (eds) "Flora of Central Australia". p. 385. (Reed: Sydney).

J. Adelaide Bot. Gard. 7(3): 295-300 (1985)

NOTES ON *TEUCRIUM* L. (LABIATAE)

H.R. Toelken

State Herbarium, Botanic Gardens, Adelaide, South Australia 5000

Abstract

Several forms in the *Teucrium racemosum*-complex are re-evaluated and the var. *tripartitum* is raised to species level as *T. albicaule* sp. nov. In *T. grandiusculum* the subsp. *grandiusculum* and subsp. *pilosa* are distinguished and formally described.

A few taxonomic changes have become necessary in the genus *Teucrium* in view of the material investigated for a new edition of the Flora of South Australia. In addition, good material was collected and observations made on the populations by Drs R.J. Chinnock and W.R. Barker on a recent expedition. This allowed a better understanding particularly of the complex involving *T. racemosum.*

1. *Teucrium racemosum*—complex

This species complex has not been much changed since Bentham (1870) completed his revision of the genus for 'Flora Australiensis". In this treatment *T. integrifolium* was distinguished in spite of doubts expressed by F. Mueller in his herbarium; modern collections confirm that Bentham was fully justified in describing the species. It is distinct from *T. racemosum* in which was included a var. *tripartitum*, based on investigation of only one specimen. Several subsequent authors have commented on the distinctness of this taxon (e.g. Willis 1972; Jacobs & Pickard 1981). These views agree with the present description of new species, *T. albicaule.* It is significant that Drs Chinnock & Barker (pers. comm.) confirm that at times the two species grow sympatrically. The similarities and differences between the three species are summarised in Table 1.

Table 1: Morphological differences between *T. albicaule, T. integrifolium* and *T. racemosum.*

	T. albicaule	T. racemosum	T. integrifolium
Plant habit	10-20 (40?) cm high, rigid.	20-60 cm high, rigid with herbaceous apices.	13-30 cm high, herbaceous.
Branches	quadrangular but densely covered with recurved hairs and apparently terete.	quadrangular & densely covered with recurved adpressed hairs and glabrescent ridges.	quadrangular and glabrescent.
Leaf shape	trifoliate linear leaflets	simple lanceolate to linear-	simple lanceolate to linear-lanceolate or ovate
Leaf margin	regularly recurved	undulate or unequally recurved	regularly recurved
Leaf size	0.3-1 x 0.1-0.2 cm	1-5 x 0.3-1.2 cm	2-5 x 0.4-2 cm
Part-inflorescence	1-flowered	1 (-3)-flowered	1-3 (-5)-flowered
Lower stalk	rigid, spreading at c. 90° to axis or curved upwards below flower	rigid, spreading at c. 90° to axis or curved upwards below flower	slender, straight ascending
Corolla lip	3.5-7 mm long	(5-) 8-14 mm long	10-16 mm long

Bentham (1870) had commented on the much smaller flowers of *T. albicaule* (his var. *tripartitum*) in comparison with those of *T. racemosum*. This was found to be particularly obvious when plants from the same area were compared. Qualified use of this character is, however, advised since many plants of *T. racemosum* mainly from the Southern Lofty and southern parts of the Murray regions have very small flowers and a complete range of intermediates is recorded.

The inflorescence of all three species is usually a botryoidal thyrse (cf. Briggs & Johnson 1979) with indeterminate growth, and each pair of flowers is subtended by a pair of leaf-like bracts which become shorter acropetalously. In the case of *T. integrifolium* and rarely in *T. racemosum*, the basal part-inflorescences develop 2-3, rarely up to 5 flowers. Although this more pronounced development of the axillary cymes is more common in *T. integrifolium* this does not justify its use to distinguish this species from *T. racemosum* (Bentham 1870; Haegi 1981) as there are many records of both species with only one-flowered part-inflorescences. In the case of *T. racemosum*, plants with more than one flower per part-inflorescence are known only from a few records from the vicinity of Oodnadatta. Although this is obviously a localised form it does not seem justified to give it taxonomic rank under the name *T. racemosum* var. *triflorum* J. Black, as this character cannot be linked with any other in a taxonomically reliable way.

Since a full range of specimens has been recorded from the Oodnadatta area it seems that judging by the generally more lush appearance, particularly large flowers and leaves, the plants with more than one flower per part-inflorescence are very vigorous individuals.

The inflorescence of these species of *Teucrium* is unusual in the family because the part-inflorescences are not sessile. This also applies to the one-flowered part-inflorescences which also have a deciduous pair of scale-like bracts between one-third to two-thirds the way along the stalk below young flowers. The whole stalk below the flower is thin and erect in *T. integrifolium*, while it is rigid and spreading at right angles in *T. racemosum* and *T. albicaule*, and may be curved upwards between the flower and scale-like bracts (=anthopodium according to Briggs and Johnson 1979).

The epithet *tripartitum* cannot be raised to species level because *T. tripartitum* Meyen (1843) has priority; this is not inappropriate since the leaves of the Australian taxon are trifoliate. Each leaflet is constricted towards the base and forms its own abscission layer independent of each other so that at times there are only two leaflets found at the base of older branches. The name *T. albicaule* was chosen because the branches of this species are usually covered with slightly spreading hairs appearing white as opposed to the more or less uniform greyish appearance of *T. racemosum*. The colour varies as some plants become stained by muddy water or dust.

Teucrium albicaule Toelken, sp. nov. similis *T. racemoso* sed foliis trifoliatis parvioribus et planta tota parviore differt.

T. racemosum R. Br. var. *tripartitum* F. Muell. ex Benth., Fl. Aust. 5:133 (1870).

Type: Murray River, *F. Mueller* s.n. (n.v.).

Perennes surculis caespes virgati vel patentes producentes, rare altiores 20 cm, ramis vix quadrangulatis, dense tectis pilis recurvatis. *Folia* trifoliata, sessilia vel subsessilia; foliola linearia, 0.3-1 x 0.1-0.2 cm, acuta, abrupte constricta ad basim et apicem, marginibus aequaliter recurvatis, pilis simplicibus distantibus et plus minusve adpressis acropete curvatis supra et subtus. *Inflorescentia* thyrsus cymis axillaribus reductis flori singulari in stipe patenti saepe curvato sursum in dimidio supero. *Sepala* pariter connata, 2-3.5 mm longa, lobis acutis, dense tecta pilis simplicibus acropete curvatis. *Corolla* alba, tubo brevi fisso postice, unilabiata, lobis duobus posticis et duobus lateralibus subsequalibus et lobis anticis circiter duplis longioribus, tecta pilis simplicibus brevibus et rare glandibus sessilibus extus, intus pilis longioribus patentibus basibus staminum cingentibus. *Stamina* 4, in fauce tubi corollae inserta, filis pubescentibus ad basim; antherae thecis duabus, excertis. *Ovarium* vix tetralobatum, stylo gracile ad apicem inserto,

stigmate bifido. *Mericarpia* anguste oblongo-obovoidea, 2-3 mm longa, cicatrice affixa magna concava in dimidio inferno paginae interioris, pilis praecipue ad apicem et glandibus sessilibus dispersis.

Type: *Chinnock & W.R. Barker* 6027, 9.3 km S of South Australian/Queensland border along Strzelecki Track (AD, holo.!).

Perennial herbs, suckering virgate to spreading tufts in stands several metres across, rarely higher than 20 cm, scarcely quadrangular stems often appearing almost terete because of dense cover of recurved hairs. *Leaves* trifoliate, sessile or with a petiolar ridge; leaflets linear, 0.3-1 x 0.1-0.2 cm, acute, abruptly tapering at both ends, margins evenly recurved, scattered simple hairs more or less adpressed and forward-directed on both surfaces. *Inflorescence* a thyrse with axillary cymes reduced to one flower on a spreading stalk often curved upwards in the upper half. *Sepals* equally connate to about half their length, 2-3.5 mm long, lobes acute, densely covered with simple forward-directed hairs. *Corolla* white, tube short, slightly split at the posterior end, one-lipped, two posterior and two lateral lobes subequal and about half the length of the anterior one, short forward-directed hairs and rarely a few sessile glands on the outside, longer spreading hairs in the area around the insertion of the stamens on the inside. *Stamens* 4, inserted in the throat of the corolla tube, filaments hairy at the base; anthers 2-celled, exerted, filaments curved from posterior to anterior well above the lip. *Ovary* scarcely 4-lobed, style slender, inserted near the apex and curved like the filaments, stigma bifid. *Mericarps* narrowly oblong-obovoid, 2-3 mm long, attachment scar a large concavity covering much of the lower half of the inner surface, hairs mainly at the top and with scattered sessile glands.

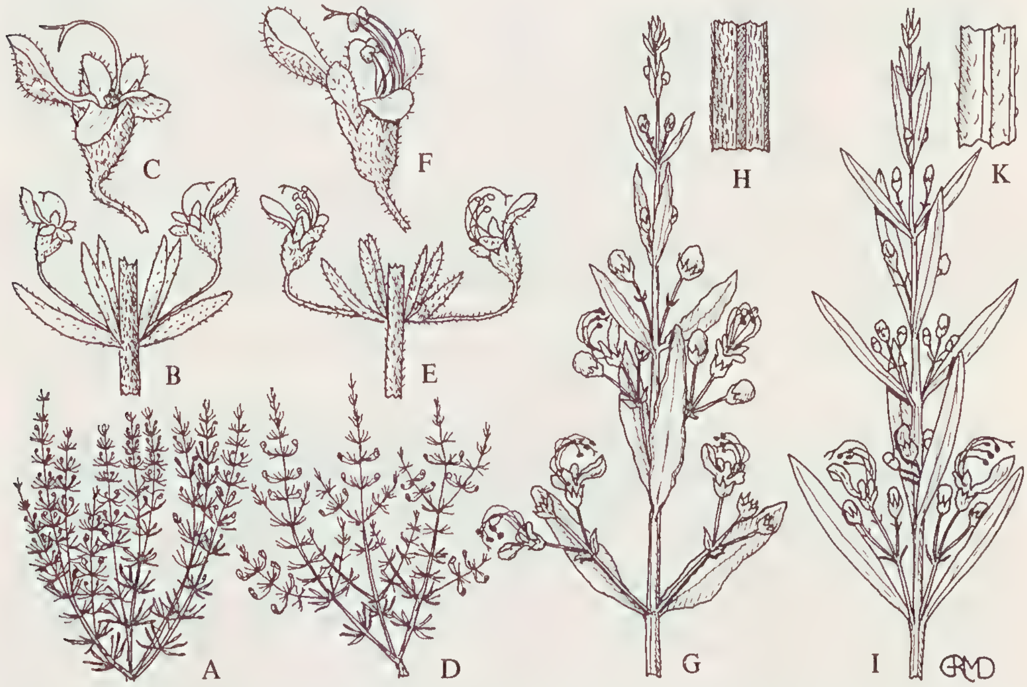


Fig. 1. A-F, *Teucrium albicaule*: A, habit, x¼; B, pair of 1-flowered part-inflorescences, x2; C, flower of female plant, x4 (*Chinnock & W.R. Barker 6027A*); D, habit, x¼; E, pair of 1-flowered part-inflorescences, x2; F, bisexual flower, x4 (*Chinnock & W.R. Barker 6027*, type). G, H, *T. racemosum*: G, flowering branch showing 1- and 3-flowered part inflorescences, x½; H, pubescent branch, x4 (*Ising AD 966140092*). I, K, *T. integrifolium*: I, flowering branch showing 1- and 3-flowered part-inflorescences, x½; K, puberulous branch, x4 (*W.R. Barker & Chinnock 4715*).

T. albicaule has been recorded from arid areas of north-eastern South Australia, south-eastern Northern Territory, south-western Queensland?, western New South Wales and north-western Victoria. Plants usually grow on clay soil in depressions which might at times be temporarily flooded. The species flowers mainly in autumn and/or spring but flowering specimens have also been recorded from other times of the year depending on seasonal rains.

Specimens examined

SOUTH AUSTRALIA: LAKE EYRE: *White* in AD 96907058, Tinga-Tingana HS, 23.ix.1916; *Schomburgk* in AD 96991009a, Lake Eyre, —; *Chinnock & Barker 6027 & 6027A*, 9.3 km S of South Australia/Queensland border, along Strzelecki Track, 15.ix.1984 (AD). EASTERN: *Crisp 700*, 8 km SW Oodlawirra, 28.ii.1974 (AD).

NORTHERN TERRITORY: *Latz 6764*, Andado Station, 14.iv.1977 (AD).

NEW SOUTH WALES: *Copley 4221*, c. 50 km SE Mildura, 15.i.1974 (AD); *Lander 233*, 70 km from Pooncarie to Wentworth, 18.x.1972 (AD); *Milthorpe 589*, Lake Muncha, 1.xii.1971 (AD).

Notes

Cunningham et al. (1982) described the plant as '15-40 cm high' but most species examined were smaller than 20 cm, or rarely up to 25 cm high.

T. albicaule, *T. racemosum* and *T. integrifolium* usually grow in a similar habitat in depressions which are often temporarily flooded. Their habit of producing small tufts by suckering over an area of several square metres is also similar. This habit, however, makes it difficult to assess which tuft belongs to which plant. This would have been useful to interpret *Chinnock & Barker 6027A* where each tuft had only flowers with sterile anthers included with the corolla tube, while other plants from the same population (*Chinnock & Barker 6027*) had hermaphrodite flowers. This strongly indicates that the plants are gynodioecious and a similar condition might be found in some plants of *T. racemosum* which Tovey & Morris (1922) described as *T. racemosum* var. *polymorphum*. Cunningham et al. (1982) commented that the latter variety differed mainly in 'minor details related to flower structure, the main one being that the stamens remain within the flower'. It is, however, not clear why they should also report that these flowers produce fewer mericarps. The phenomenon could not be found in any specimens of *T. racemosum* from South Australia. It is also interesting that several species of *Ajuga* from Europe (Gams 1927, p. 2538) which have a very similar floral morphology to *Teucrium* species, have been shown to be gynomonoecious.

2. *T. grandiusculum*

T. grandiusculum has a rather scattered distribution with many records from its northern range while its two southern occurrences are localised and well separated from the northern localities as well as from one another. In the northern part the localities are also somewhat disjunct but mainly because its occurrence is restricted to mountainous areas in north-western South Australia, south-western Northern Territory and adjoining Western Australia. These specimens are remarkably similar and characterised by their short sparse gland-tipped hairs, while specimens from the southern localities have a variety of eglandular hairs, the longest of which are three to five times as long as those from northern localities. Occasionally, a few hairs of this latter group of specimens are also gland-tipped especially on the flower stalk and calyx, but these hairs are thin in contrast to the rather stout ones which are visually constricted below the terminal gland on plants from the north. These form two distinct and geographically isolated subspecies.

Hairs on branches few, up to 0.3 mm long and gland-tipped .... subsp. *grandiusculum*
Hairs on branches dense, up to 1.5 mm long and eglandular .... subsp. *pilosum*

a. **T. grandiusculum** F. Muell. & Tate, Trans. R. Soc. S. Aust. 13:108 (1890) subsp. **grandiusculum.**

Whole plant covered with short hairs up to 0.3 mm long, each gland-tipped, usually only few on quadrangular branches. *Leaves* 0.8-3 x 0.6-2 cm, with cuneate base often broadened in the middle, with 5-17 teeth often reaching onto the lower half, with margin not or scarcely recurved. *Bracts* subtending part-inflorescences often with 1-3 apical lobes or teeth.

Known from the Tomkinson Ranges in Western Australia and north-western South Australia as well as from a few localities in south-western Northern Territory. Most records are from ravines or associated with watercourses.

Specimens examined

WESTERN AUSTRALIA: *Helms* in AD 96910090, between camps 23 and 24 in Tomkinson Ranges, 17.vii.1891.

SOUTH AUSTRALIA: NORTH WEST: *Cleland* in AD 966071293, Mt Davies in Tomkinson Ranges, 29.vi.1960; *Reid 108*, Mt Davies, 24.ix.1955 (ADW).

NORTHERN TERRITORY: *Chippendale 2662*, Palm Valley, 25.iii.1957 (AD): *Hill & Lothian 922*, c. 5 km west of Blackstone mining camp, 11.vii.1958 (AD).

Note

It is not evident why the flower of this species was illustrated in fig. 417 (Haegi 1981) with anthers included in the corolla tube when they are usually exserted well above the lip. As no specimen could be found with functionally female flowers (cf Note under *T. albicaule*) it is assumed that the figure was reconstructed from an immature flower.

b. subsp **pilosum** Toelken, subsp. nov.

Planta tectis tota pilis longis usque ad 1.5 mm longis eglandulosis vel rare paucis glandulosis in stipite floris, ramis quadrangularibus dense tectis pilis pilosis et ut videtur teretibus. *Folia* 0.8-1.8 x 0.4-1.2 cm, marginibus plerumque recurvatis. *Bracteae* in axe principale 5-lobis vel dentibus.

Type: *Whibley 729*, south side of the railway line, Ooldea, 20.ix.1960 (AD, holo.!; AAU, COLO, iso.)

Plant covered with long hairs up to 1.5 mm long, eglandular or rarely with a few glandular ones on the flower stalk, with quadrangular branches densely covered with spreading hairs so that they appear terete. *Leaves* 0.8-1.8 x 0.4-1.2 cm, with straight cuneate base, subpetiolate, with 5-9 teeth confined to the upper half of the leaves, with margins usually recurved. *Bracts* subtending part-inflorescence with 5 lobes or teeth.

This subspecies is known only from two localities from near Ooldea and on the western side of Lake Everard; it has been recorded to occur in surface limestone.

Specimens examined

SOUTH AUSTRALIA: NULLABOR: *Caulfield 115*, Ooldea, 25.ix.1955 (AD); *Hilton* in ADW 18691, Ooldea, 24.iii.1955; *Whibley 729*, Ooldea, 20.ix.1960 (AD).

GAIRDNER-TORRENS: *Reid* in ADW 26182, western boundary of Lake Everard, 1.iv.1960; *S.A. Pastoral Board* in AD 97930141, western Lake Everard, 1.iv.1960.

Acknowledgements

The author is indebted to Drs R.J. Chinnock and W.R. Barker who took the trouble to collect and make some observations on the population of *Teucrium* species in north-eastern South Australia and southern Queensland. Thanks are also due to Dr L. Haegi for discussions and exchange of observations on the *T. racemosum*-complex.

References

Bentham, G. (1870). "Flora Australiensis" 5:132, 133. (Reeve: London).

Briggs, B.G. & Johnson, L.A.S. (1979). Evolution in the Myrtacaea—evidence from inflorescence structure. *Proc. Linn. Soc. N.S.W.* 102:157-256.

Cunningham, G.M. et al. (1982). "Plants of western New South Wales" 577, 578. (N.S.W. Govt Printer: Sydney).

Gams, H. (1927). In Haegi, G. (ed.). "Flora von Mitteleuropa" 5, 4:2538. (C. Hanser: Munchen).

Haegi, L. (1981). In Jessop, J.P. et al. (eds). "Flora of Central Australia". (A.W. Reed: Sydney).

Jacobs, S.W.L. & Pickard, J. (1981). "Plants of New South Wales" 138. (N.S.W. Govt Printer: Sydney).

Tovey, J.R. & Morris, P.F. (1922). Contributions from the National Herbarium of Victoria 2. *Proc. Roy. Soc. Vict.* n.s. 35:89, p.6.

Willis, J.H. (1922). "A Handbook to Plants of Victoria" 2:584. (Melbourne University Press: Carlton).

J. Adelaide Bot. Gard. 7(3): 301-302 (1985)

A NEW SPECIES OF *SWAINSONA* (FABACEAE)

J.Z. Weber

State Herbarium of South Australia, Botanic Gardens, North Terrace, Adelaide 5000

Abstract

Swainsona leeana J. Weber is described and its similarities with other species as well as its distinguishing features are discussed.

During the preparation of *Swainsona* for the new "Flora of South Australia", an undescribed species was isolated. One collection made by A.J.A. Sikkes at Mt Lyndhurst, Flinders Ranges, had previously been annotated by A.T. Lee in 1974 as being an undescribed *Swainsona*, and since then further material has become available so that the species is here formally described. The specific name honours Mrs Alma Lee for her contribution to our knowledge of this genus.

Swainsona leeana J. Weber, spec. nov.

Herba annua, pubescens pilis basifixis; *ramis* radiatis, ad 20 cm longis; *folia* 10-25 mm longa. 5-7 foliata, foliolis oblongo-ovatis, 5-10 x 2.5-4 mm; *stipulae* foliosae, angusto-triangulares, 3-4 mm longae; *pedunculi* filiformi, 20-35 mm longi; *flores* lutei, 4-5 mm longi, in pedicello circa 1 mm longo, bracteis paulo longioribus, bracteolis minutis, in pubescentia calycis occultantibus; *calyx* 2.5-3 mm longus, pubescens, tubo et dentibus subaequilongus; *vexillum* cordiformum, cucullatum, ecallosum, ungue circa 0.5 mm longo, triangulare; *alae* ovato-oblongae; *carina* obovato-cuneata, apice subacuto, asinuato, ungue fere 2 mm longo; *ovarium* adpresse cano-pubescens, stylo barbato, gracile apice, inflexo, post stigman caespitosus; *legumen* oblongus, 9-12 x 5-7 mm, leviter dorso-ventraliter compressus, adpresse cano-pubescens; *semina* ad 20, cordiformia, circa 2 mm longa. Fig. 1.

Type: *A.J.A. Sikkes 1109*, 26.ix.1973, Mount Lyndhurst, 35 km NE of Lyndhurst, northern Flinders Range, South Australia (AD 97850151, holo!; CBG 054494!, K, NSW, iso.).

Apparent annuals, prostrate slender. *Stems* to 20 cm long, radiating from central tap root; *indumentum* of soft white basifixed hairs, moderately appressed, sparse on stems and peduncles, denser on leaves. *Leaves* 10-25 mm long, with 5-7 leaflets; leaflets oblong-ovate, 5-10 x 2.5-4 mm, more densely pubescent underneath; stipules narrow-triangular, 3-4 mm long, leafy, pubescent on both sides. *Flowers* 4-5 mm long, on 1 mm long pedicels, covered with white and brown hairs, in 1-3-flowered terminal racemes on filiform peduncle 20-35 mm long, awned terminally, prostrate when pods are mature; bract ovate-lanceolate, slightly exceeding pedicel, pubescent; bracteoles filiform, at base of calyx, pubescent. *Calyx* 2.5-3 mm long, densely covered with white and brown long spreading hairs, teeth narrow-triangular acuminate, almost equalling the tube in length. *Petals* yellow; *standard* cordiform hooded, as broad as long, not suddenly attenuated into triangular 0.5 mm long claw; lamina with radiating veins, without calli or thickenings, remaining folded during flowering; *wings* ovate-oblong, obtuse, shortest, distinctly auriculate above the filiform 0.7 mm long claw; *keel* obovate-cuneate; tip subacute, more or less at right angles, without folds or pouches. *Ovary* subsessile, semilunar in outline, densely pubescent with appressed white hairs; style slender, curved, unevenly bearded in basal two-thirds densely bearded in upper part, with hair tufts behind inflexed stigma; *legume* subsessile, oblong, obtuse at both ends, 9-12 x 5-7 mm, slightly incurved, dorsiventrally flattened, walls thin but firm, often brown, pubescent with white appressed hairs, c. 20-seeded; seed cordiform, c. 2 mm across, olive-green, mottled dark.

The species is restricted to the upper Flinders Ranges in South Australia except for a single collection from Wingellina in Western Australia close to the South Australian and Northern Territory border.

Plants were found on rocky slopes and in semi-arid tussock grassland with a *Ptilotus* sp., and saltbush. A plant in cultivation in Canberra from seed obtained from the type specimen was slightly larger and more vigorous, but apparently with less indumentum on the leaves (*A. & C. Tyrrel 209*).

The species shows similarities with *S. oroboides* F. Muell. ex Benth. in having a prostrate habit and at maturity the legumes lying on the ground. *S. oroboides* has stouter peduncles with flowers 7-9 mm long, a style abruptly inflexed into a geniculate tip, and without any ring or hair tufts behind the stigma. It can be easily distinguished from *S. flavicarinata* J. Black which also has yellow flowers, but these are 8-10 mm long and the legumes are borne on upright peduncles at maturity.

The species may be keyed out by adding the following couplet after lead 28 in the key by A. Lee, Contr. N.S.W. Natn. Herb. 1 (4): 263 (1948).

28. Flowers very small (4-5 mm long), the wings minute; style tip incurved or coiled with very short hairs behind the stigma 28a

28a. Leaflets 9-13; peduncle continued into an awn; legume fusiform . . . . (47.) *S. oliveri*

28a. Leaflets 5-7; peduncle not continued into an awn; legume oblong-obtuse . . . . *S. leeana*

Specimens seen:

SOUTH AUSTRALIA: *A.J.A. Sikkes 1109 & 1125*, 26.ix.1973, Mount Lyndhurst, 30°07′S, 138°35′E, (CBG); *A. & C. Tyrrel 209*, 24.x.1978, (cultivated at CBG from the seed of the type specimen) (CBG); *D.J.E. Whibley 4040*, 13.ix.1973, Moro Gorge, 30°41′S, 139°13′E, (AD; duplicates n.v., CHR, PRE, SYD.).

WESTERN AUSTRALIA: *R.H. Kuchel 62B*, 31.vii.1962, Wingellina, 26°03′S, 128°56′E, (AD).

J. Adelaide Bot. Gard. 7(3): 303-306 (1985)

BOOK REVIEWS

Blood-lily systematics: for botanist and plantsman

Snijman, D. 'A Revision of the Genus *Haemanthus* L. (Amaryllidaceae)', 1984, Supplementary Volume no. 12, *Journal of South African Botany.*

Those involved with the identification of cultivated plants are frequently confronted with material of unknown geographical origin, and are therefore often dependent on inadequate, horticulturally-oriented literature usually lacking keys. In many cases, it is not possible to determine whether a relevant regional flora is available. Even with increasing enlightenment on the part of botanic gardens in growing plants of known wild origin, successful identification will continue to rest heavily on the availability of well illustrated comprehensive generic revisions. Such works are, alas, all too few, but among them, Deirdré Snijman's revision of *Haemanthus* ranks with the best.

Haemanthus is known in cultivation mainly through the widely-grown species *H. coccineus*. If Snijman and other recent workers are to be followed, several species generally grown as *Haemanthus* are among those which should be referred to the genus *Scadoxus* (rhizomatous rootstock, thin-textured leaves, $2n$=18), leaving *Haemanthus* s. str. (true bulbs, fleshy leaves, $2n$=16) with 21 species.

Maintaining the high standard set by a revision of South African *Gladiolus* published as Supplementary Volume 10 of the same series, the Journal of South African Botany has produced, with careful attention to detail, a lavishly illustrated monograph of *Haemanthus*. The publication includes no fewer than 24 colour plates, 'to convey such taxonomically important features as texture, colour and markings of the floral and vegetative parts'. These illustrations are beautifully executed by the artists Ellaphie Ward-Hilhorst (23 plates) and Fay Anderson (1 plate), and succeed in their aim. It is not clear whether the lack of subtlety in the highlighting on leaves of three plates (7, 17, 20) is an artefact of reproduction, since in other respects, all plates are impeccably printed.

Each of the four species and three subspecies newly described by Snijman are illustrated with colour plates. Only five of the 21 species are not illustrated in colour. The provision of two colour plates for variants in each of three species seems excessive, though the two plates of the very variable species *H. coccineus* are certainly useful.

The text is in clear 10-point on good quality matt paper with effective use of headings, type-faces and setting out, making it a delight to read and use. The arrangement of details of specimens cited is perhaps a little wasteful of space. Clear distribution maps are presented for each taxon, and some half-tone plates, mainly of type specimens, are included. Figure 6, a reproduction of a photograph of a Cape Honey bee alighting on an inflorescence would better have been omitted since it is poor and conveys little information, especially as to the identity of the bee. Figure 7 is poorly exposed.

The scientific content of this monograph matches the high standard of presentation. A concise introductory section, for the most part based on thorough investigations, deals with background, methods, morphology, geography, ecology and habitat, evolution and various aspects of biology. Included is a detailed account of the structure of the various bulb types found in the genus; this could have been improved only by better illustration of median as compared with lateral compression of the bulb. It is the discussion on evolution and relationships, however, which is disappointing. Although a table arranging the species into four groups is presented, a synopsis indicating the characters on which this is based is lacking. The discussion outlining the relationships is not entirely clear, but it would appear

that species representing early off-shoots of different phylogenetic lines are united in the *H. humilis* group, on the common possession of primitive characters.

The taxonomic treatment comprises clearly presented synonymies, well written, cross-comparable descriptions, flowering and 'leafing' times, distribution and habitat details, notes (including variation) and lists of cited specimens. A workable, though probably fairly narrow species concept is adopted, while the assignment of subspecies rank has a sound basis and the temptation of subdividing the very variable and widespread *H. coccineus* is resisted. The habitat information presented is generally sufficiently detailed to be of use in gauging requirements in cultivation. Although distinctive features are detailed for all species, more reference to particular characters distinguishing a taxon from its closest relatives, or from morphologically similar taxa would have been useful. All new taxa are furnished with full Latin descriptions which are well written with the exception of one peculiarity: they are composed of several sentences each beginning in the nominative for the first clause but with the subjects of subsequent clauses in the ablative.

One further commendation would seem to be in order. It is heartening to see space made available not only for the inclusion of two identification keys but also for several species to be keyed out more than once. The main key is the second one, based primarily on floral characters. This is well-written, with contrasting leads which agree with the descriptions. Leaf characters are reserved for ultimate couplets and used only when really necessary to distinguish taxa. This is important because most species flower before leaves are produced. My only criticism of this key is the use of purely geographical criteria at couplet 23.

While the inclusion of a second key based mainly on vegetative characters is highly commendable, it is unfortunate that the best has not been made of this opportunity. The main reason for including such a key is that it allows some progress to be made with identification of leaf material of species in which flowers and leaves are produced at separate times. Regrettably, more than two thirds of these species follow a couplet based entirely on floral characters: such characters could have been reserved for use in later leads and only where absolutely necessary. Despite these minor criticisms I am sure that many will join me in the hope that the author, artists and publisher who combined to produce this excellent volume have plans for future taxonomic publications on groups of horticultural importance.

Snijman, D. 1984. 'A Revision of the Genus *Haemanthus* L. (Amaryllidaceae)', pp. 139, figures 32, with 23 colour plates by E. Ward-Hilhorst and one by Fay Anderson. (Published by *Journal of South African Botany*, as Supplementary Volume no. 12). Hard-bound. Price R20.

L. Haegi,
Botanic Gardens of Adelaide

Plants of the Cape Flora

Bond, P. & Goldblatt, P. 'Plants of the Cape Flora. A descriptive catalogue'.
1984, Supplementary Volume no. 13, *Journal of South African Botany.*

This mammoth compilation of 8505 species in 150 families and 955 genera demands special attention as it is the only recent book which deals with the whole of the Cape Flora. Each species is accompanied by a brief diagnosis, the flowering time, a broad distribution range, sometimes with ecological notes and often with a common name. The diagnostic characters are usually sufficient to identify plants at least in the smaller genera that is, if one

knows by previous experience the name of the genus as there are no keys or references to where one would find keys. It is thus a checklist of the species with some synonyms mentioned only in a few families. For checking names the 'List of species of Southern African plants' by Gibbs Russel (1984) has the advantage that it covers the whole of the Southern African flora and includes subspecific taxa, but it is merely a list, whereas 'Plants of the Cape Flora' has a little additional information.

The format of this publication is based on Beard's (1965) 'A descriptive Catalogue of West Australian Plants'. It is a pity that the authors were not inspired by this example to designate some phytogeographic units within the Cape Region even if only as a basis for further discussion.

Contrary to hopes expressed by the authors that it "will fill an important gap in the literature both for researchers in the area and for science at large" this is hardly likely as there are very few references given in the introductory chapters of the book and none at all under the family or genus. The use of some names is complicated because while one may not find them in existing literature, "species not yet published, but with the exprectation that they will be within a year of the appearance of this work, are treated as valid names"! This should not cause undue concern in the long run except that authors have been known to change their preference for a certain epithet while the species are being prepared for publication.

In the chapter on 'How to use the catalogue' no mention is made of Dyer's (1976) 'The Genera of Southern African flowering plants', which is the only recent publication with keys to families and genera, as well as references to recent revisions, so that it would be the obvious book to use in conjunction with this Cape Flora catalogue. The Dyer reference is mentioned only in passing as a basis for the families and genera, but had to be adapted because of new information published since its publication.

The introductory chapters are very informative and show in the case of 'Geographic Definition' the difficulties involved in deliminting the area. In parts arbitrary decisions have to be taken and relics of this flora on the Groot River Heights and Zuurberg Ranges have been left out to simplify a nevertheless complex evaluation. The definition of the Cape Floristic Region in terms of vegetation types is problematic. As the Cape Region (as accepted above) includes vegetation types which extend their distribution far beyond the set boundaries. The Cape Region as boldly outlined on the end papers of the book is a mosaic of different vegetation types extensively moulded in time and space mainly by changing climatic conditions, several mountain ranges and unusually poor sandy soils often leaving only small refugia for some communities. There is evidence that the flora has been isolated for a long time, and the species of several families have radiated out in an evolutionary sense into a wide range of niches, while others have shown a proliferation of species e.g. Ericaceae with 650 endemic species of *Erica*.

The 'Analysis of the Flora' demonstrates importance of this unique flora. Although it occupies ca 90,000 sq.km, or less than 4% of Southern Africa it includes between 40% and 46%, or 8505 species of the flora. Six families, 193 genera and 68.2% of the species are endemic to the Cape Region. This percentage of endemism is lower than that of isolated islands such as New Zealand, but considerably higher than any floristic region on a larger land mass. Although these figures are largely based on Goldblatt (1978) and Raven and Axelrod (1978), many of them were adapted to include new information. Appendix 1 provides details of the genera and species, each with their number of endemics in the 150 families enumerated. This table shows at a glance the more important families of the Cape Flora according to their size and number of endemics.

The 13 photographs were well selected to show some aspects of the varied nature of this region. The whole work was obviously typed on E.D.P. which has produced a different type

face unusual for this Journal. Editorially interesting is the use of the abbreviation sp (without full stop) for one or more species presumably because it is a plural noun. The abbreviation of Peninsula for what must be assumed to be the Cape Peninsula throughout the check list is not explained, and, is at first confusing, because the unabbreviated form is used throughout the introductory chapters. Leguminosae, the more common alternative name for the Fabaceae cannot be found in the check list of the general index, although other names are cross indexed. From an Australian point of view it is almost incredible how few alien species have naturalised although it is stated that exotic species readily become established and displace the native flora.

In spite of these minor shortcomings the work is an amazing compilation which should be useful as an interim reference, but foremost will hopefully promote more research on a unique floristic region which is often classified as one of the six floral kingdoms of the world.

Bond, P. & Goldblatt, P. (1984). 'Plants of the Cape Flora'. A descriptive catalogue pp. 455, 13 colour photographs. (Published by *Journal of South African Botany*, as Supplementary Volume No. 13) Hard-bound. Price not known.

H.R. Toelken,
State Herbarium of South Australia.

J. Adelaide Bot. Gard. 7(3): 307-313 (1985)

PLANT PORTRAITS

17. **Acacia araneosa** Whibley (Leguminosae)

Acacia araneosa Whibley, Contrib. Herb. Aust. 14: 1 (1976); Acacias of South Australia 94 (1980).

Illustration: Based on fresh material preserved under *Whibley 9687* from a plant grown in the Mallee section of the Adelaide Botanic Gardens.

Small erect wispy trees 3-8 m high; trunks slender 4-7 cm in diameter, solitary or dividing at about 1 m above ground level. *Branches* smooth, flexuose towards their apices; bark smooth, a grey reddish brown on juvenile branches. *Phyllodes* slender, terete, 18-35 cm or sometimes up to 69 cm long, 1-1.8 mm in diameter, becoming almost tetragonous when dry, obscurely 4-nerved, glabrous, light green, sometime scurfy, tapered at the apex into a non-pungent point. *Glands* small, orbicular and situated near the base of the phyllode. *Inflorescence* axillary racemes which become paniculate at the ends of branches due to phyllode reduction; racemes with 5-9 sparsely arranged heads; flower heads yellow, compact globose with 50-70 flowers; petal 5, free, sparsely golden hairy on the acute tips. *Legumes* stipitate, linear, straight or slightly curved, 6-14.5 cm long, 4-6 mm broad, coriaceous, undulate, glabrous, olive green, becoming brown when mature; margins prominent, nerve-like and somewhat constricted between seeds. *Seeds* longitudinal or slightly oblique in legume; funicle a yellow reddish brown, extending c. three-quarters around the seeds and terminating in a yellowish clavate aril.

Acacia araneosa occurs in a small area of the northern Flinders Range from Balcanoona along the range into the Arkaroola Sanctuary. This species occurs within the Gammon Range National Park and is considered an endangered species by Leigh, Briggs and Hartley 1981 with the classification of 2 E C, i.e. the population is too small to ensure survival even if present in a proclaimed National Park. The survival of the plants could be threatened by the predation of goats and I have personally noted severe damage to some trees being battered and broken down. With severe climatic conditions and drought periods natural pressure is brought to bear on these plants to survive and re-establish.

This graceful plant is found on calcareous soil on hillsides and ridges often in dense stands associated with *Eucalyptus gillii* and *Triodia irritans*. It flowers throughout the year so that mature pods and flowers can be found on the same trees.

Acacia rivalis is common in the surrounding area and a variant with phyllodes flat and 1-3 mm—possibly a hybrid between *A. araneosa* and *A. rivalis*—wide has been collected with the main population of *A. araneosa* and grown successfully in the Adelaide Botanic Gardens and a private garden. *A. araneosa* is a very distinctive species which is distinguished from other South Australian species of *Acacia* by its long terete phyllodes and light wispy appearance.

Other species of *Acacia* which are considered closely allied are *A. rivalis*, *A. harveyi*, *A. chrysella* and *A. juncifolia*. The first specimens of it were collected in 1966 by Mr F.J. Vickery & J.L. Johnson, members of the South Australian Pastoral Board near Nudlamatana Well, c. 15 km NW of Bacannoona Homestead.

Reference

Leigh, J., Briggs, J. & Hartley, W. (1981). 'Rare or threatened Australian Plants'. (Austr. Natl Parks & Wildlife Serv. Special Publ. 7: Canberra).

D.J.E. Whibley
State Herbarium of South Australia

Del. G.R.M. Dashorst
State Herbarium of South Australia

Acacia araneosa Whibley. A, flowering and fruiting branch; B, flower; C, flower head with flowers removed; D, transverse section through leaf; E, attachment of leaf to branch; F, legume; G, opened legume to show seed and funicle.

18. **Anthocercis angustifolia** F. Muell. (Solanaceae)

Anthocercis angustifolia F. Muell., *Trans. Philos. Soc. Victoria* 1 (1855) 21.

Illustration: Based on fresh material preserved as *L. Haegi 2694*, 13.viii.1984, 14 km NE of Adelaide, in Torrens River Gorge, 34°51′S, 138°44′E (AD).

Erect, usually sparingly-branched shrub 0.3-2.5 m high with corky bark at stem-base. *Branches* initially remaining photosynthetic, smooth, moderately to densely pubescent with porrect glandular hairs 0.2-0.5 mm, sessile glandular hairs c. 0.05 mm and sometimes simple eglandular hairs 0.1-0.15 mm, the indumentum soon becoming sparse with only scattered eglandular hairs remaining. *Leaves* sessile, often with rapid otherwise with gradual decrease in size distally; *lamina* usually ± linear, sometimes narrowly to very narrowly elliptic to obovate, length:breadth (3.3-) 4-18 (-25), usually 2-40 (-50) x 0.5-3 (-6) mm but up to 95 x 8 mm on seedlings, densely pubescent above with glandular hairs mainly 0.05-0.1 mm and fewer 0.2-0.4 mm, especially towards the margins, moderately pubescent below with glandular hairs 0.2-0.4 mm, the lower leaves glabrescent; *base* truncate to attenuate; *apex* bluntly to angularly acute; *margin* entire, usually slightly recurved, sometimes ± flat; *midrib* obscure to faintly indented above, slightly prominent to obscure below. *Flowers* malodorous, solitary and extra-axillary (when usually leaf-opposed), or terminal, the leaves in the flowering region very small, but otherwise similar to stem leaves. *Pedicel* (2-) 3-6 mm, oblique, moderately to densely pubescent with variable porrect glandular hairs 0.05-0.65 mm and sometimes scattered simple eglandular hairs 0.08-0.15 mm. *Calyx* 4.0-7.0 mm long, moderately to densely pubescent outside with porrect glandular hairs 0.1-0.65 mm and sometimes simple eglandular hairs 0.1-0.15 mm, inside moderately pubescent with porrect to antrorse glandular hairs 0.05-0.1 mm and fewer to 0.2 mm especially towards lobe apices; *calyx-lobes* 2.2-3.5 (-4.3) x 0.7-1.3 mm, bluntly to angularly acute, clearly longer than the tube [ratio 1.4-2.3]. *Corolla* with funnel-shaped tube and patent, stellate, sub-regular limb, 19-27.5 mm in total length, white to creamy-yellow with green striations in throat and faint violet longitudinal bands on tube outside, sparsely to moderately pubescent outside with porrect glandular and sometimes eglandular hairs 0.1-0.35 mm, inside densely papillate on the lobes with papillae 0.05-0.25 mm; *tube* patent for 0.7-1.5 mm below the limb-base, 6.5-8.3 mm long, diam. 1.5-1.8 mm at base, broadened to 4.5-7 mm and then to 6-8 mm, with three ribs of raised tissue running to the base from each lobe; *lobes* linear [L:B 4.5-6.8], 12.5-19.5 x 2-3.5 mm, apex angularly acute, margin flat. *Stamens* 4, didynamous, 4.7-6 and 3.2-5 mm; *staminode* 1.2-4.5 mm; *anthers* bilocular, 0.9-1.3 x 0.7-1.4 mm, the upper pair 0.5-1.7 mm below corolla-tube orifice. *Ovary* ovoid-ellipsoid to broadly ovoid, 1-1.5 (-2) x 0.6-1.3 mm, surrounded at base by an orange-yellow annular disc; *ovules* 14-21; *style* 3.9-4.6 mm, 0-0.7 mm above upper anthers; *stigma* 0.2-0.3 x 0.5-0.7 mm. *Capsule* broadly ovoid-ellipsoid to truncate-pyriform, (4.5-) 5.5-8 (-8.5) x (4-) 4.5-5 mm. *Seeds* 9-18, 1.7-2.2 x 1-1.1 mm, with reticulate surface.

The genus *Anthocercis* belongs to the almost endemic Australian tribe Anthocercideae in family Solanaceae (Purdie et al. 1982; Haegi 1983). Of the nine species in the genus, eight occur in Western Australia, where seven species are endemic. The distribution of one Western Australian species (*A. anisantha*) extends to Eyre Peninsula in South Australia. *A. angustifolia*, a South Australian endemic, is found in the Mount Lofty Ranges near Adelaide and in the Flinders Ranges, representing the most eastern occurrence of the genus. Its relatively large white or pale yellow scattered flowers combined with the long narrow glandular leaves make this a distinctive species within the genus.

A. angustifolia usually occurs along deeply cut watercourses, not close to streams, but on the steep, rocky, often dry, slopes above them, in clayey-loam soils. The substrate parent material in the areas of occurrence is quartzite. This species is a pioneer which becomes locally abundant following disturbance, in particular fire, the population then gradually declining. In the Torrens River Gorge where the material for the illustration was collected

Anthocercis angustifolia F. Muell. A, habit; B, basal part of stem showing corky bark; C, new shoot with large leaves; D, flowering branchlet; E, flower in distal view; F, advanced bud opened out; G, flower with perianth removed, showing extrorse positioning of anther slits; H, capsule; I, seed.

this species is found as scattered plants on a steep north-facing rocky slope growing in humus-rich soil of pH6, in an open shrubland, with *Dodonaea viscosa* ssp. *spatulata*, *Olearia tubuliflora*, *Trymalium wayi*, *Phyllanthus saxosus*, *Xanthorrhoea quadrangulata*, *Pimelea stricta*, *Logania vaginalis* and *Hibbertia sericea* with scattered trees of *Allocasuarina verticillata* and some *Banksia marginata*.

Although the total distribution of this species spans c. 400 km, the populations are small and scattered and the plant is considered rare. It occurs in the Morialta, Telowie Gorge and possibly Black Hill Conservation Parks and in the Flinders Ranges National Park. It is assigned the conversation status 3RC by Leigh et al. (1981).

Like most Anthocercideae, *A. angustifolia* has protogynous, malodorous flowers with the anthers dehiscing extrorsely after the stigma has withered (Haegi 1983). Although a coloured moist annular disc is present around the base of the ovary, nectar does not appear to be produced. Pollen vectors have not been observed but seem to be necessary for pollination. The sympodial growth of the flowering region continues to produce flowers over a period of six months, from May to November.

Although unknown in cultivation, *A. angustifolia* is a plant of some potential in ornamental horticulture. During its extended, useful, winter and spring flowering period it presents a striking sight, covered in white or pale yellow delicate star-shaped flowers. It prefers well-drained, slightly acid soils and is probably best propagated from seed. Moderate to heavy pruning following flowering would assist in producing a more compact plant of better proportions.

All species of *Anthocercis* contain alkaloids (Evans & Ramsey 1983) and the only sample of *A. angustifolia* known to have been tested, proved at 0.1%, to have the highest alkaloid content of any species of the genus (W.C. Evans, University of Nottingham, pers. comm., May 1979). Half of this was accounted for by hyoscyamine, an alkaloid related to the commercially more important hyoscine which is found in considerable quantities in species of *Duboisia*, also of tribe Anthocercideae. The presence of a new alkaloid, acetoxyhyoscyamine, has been tentatively recorded from *A. angustifolia* (Evans & Ramsey 1982).

References

Evans, W.C. & Ramsey, K.P.A. (1983). Alkaloids of the Solanaceae Tribe Anthocercideae. *Phytochemistry* 22 (10), 2219-2225.

Haegi, L. (1983). 'Systematic and Evolutionary Studies in the Australian Solanaceae'. Ph. D. thesis, Flinders University of South Australia, xi, 568p.

Leigh, J., Briggs, J. & Hartley, W. (1981). 'Rare or Threatened Australian Plants' p. 178. (Australian National Parks and Wildlife Service: Canberra).

Purdie, R.W., Symon, D.E. & Haegi, L. (1982). Solanaceae. In A.S. George (Ed.), 'Flora of Australia', vol. 29 (Aust. Govt Publishing Service, Canberra).

L. Haegi
Botanic Gardens of Adelaide

Del. G.R.M. Dashorst
State Herbarium of South Australia

19. **Eremophila barbata** Chinnock, sp. nov. (Myoporaceae)

Illustration: Based on the type specimen and on a cultivated plant from the type collection.

Frutex parvus ramis manifeste tuberculatis, glabris; *foliis* sessilibus alternis, obovatis, serrulatis, maculatis tuberculatisque in paginis abaxialibus, glabris; *floribus* solitaribus, sessilibus; *corolla* lilacina, extra glabra, intra-tubo villosa, labi inferni lobo mediano barbato; *staminibus* 4, glabris; *ovario* oblongo, glabro; fructu cylindrico glabro.

Eremophila barbata Chinnock. A, habit; B, enlarged portion of branch; C-D, abaxial surface of leaf showing scattered tubercles (C) and translucent spots (D); E-F, side and front view of flower; G-H, abaxial and adaxial surface of sepal; I, gynoecium; J, fruit; K-L, cross-section of fruits to show 2-locular fruit without seed (K), and fruit filled by one seed (L).

Type: *R.J. Chinnock 4996*, Hincks National Park, South Australia, 21.x.1979 (holotype: AD; isotypes CANB, K, MEL, MO, NSW, PERTH, US, W).

Small shrub to 1 m tall. *Branches* spreading, terete, pale brown but often purplish towards tips, prominently tuberculate, glabrous. *Leaves* sessile, alternate, clustered, spreading, green often purplish along margins, slightly glaucous, obovate, 5-9 (-10) x 3-7.5 mm, obtuse, margins serrulate, surface flat or undulate with scattered tubercles projecting from abaxial side and a few translucent spots showing through lamina; minutely glandular-papillose, glabrous, non-viscid but older leaves often shiny. *Flowers* solitary, sessile. *Sepals* 5, linear-subulate, 2-5 x 0.5-1 mm, glabrous. *Corolla* 7-12 mm long, lilac, unspotted, glabrous outside, inside of tube villous, medial lobe of lower lip prominently bearded; lobes acute. *Stamens* 4, upper pair included, lower pair often exserted beyond throat, glabrous. *Ovary* oblong but slightly dilated at base, c. 1.5 x 0.6 mm, obtuse, pale yellow, bilocular with two ovules per loculus, glabrous; style glabrous. *Fruit* cylindrial, slightly constricted at base and apex, 2.5-3.5 x 0.8-1 mm, glabrous. *Seed* unknown.

The most closely allied species to *E. barbata* are *E. crassifolia* and *E. behriana* and the latter species is known to occur sympatrically with it. *E. barbata* differs from these species in having glabrous branches, leaves with serrulate margins, prominent translucent spots which show through the lamina and narrower cylindrical fruits.

Eremophila barbata is extremely rare being restricted to a small area in Hincks Conservation Park on Eyre Peninsula. Although extensive searches have been made for *E. barbata* within the Conservation Park and outside, it has only been found in one small area and the two creeks immediately to the south.

The vegetation is a low mallee scrub 2-3 metres tall dominated by *Eucalyptus dumosa*, *E. floctoniae* or *E. calycogona*. Interspersed with the mallee scrub are occasional thickets of *Melaleuca uncinata*. *Eremophila barbata* occurs in mallee scrub where it sometimes dominates the understorey and grows on rocky clay (sometimes slightly sandy) loams. It is absent from the *Melaleuca* dominated areas.

Eremophila barbata has been in cultivation in South Australia since 1978 and it is now quite commonly grown. Unlike wild plants which grow erect to 1 metre, cultivated plants are always low growing and spreading, rarely attaining 0.25 m tall. They exhibit a similar growth habit to that displayed by many conifers where cuttings derived from lateral shoots never develop into erect growing ones but merely continue to grow laterally.

Acknowledgements

I thank Mr Peter Hudson, Whyalla, who has made extensive searches for *Eremophila barbata* and provided ecological data on the species.

R.J. Chinnock
State Herbarium of South Australia

Del. L. Dutkiewicz
Adelaide

CORRIGENDUM

The proposed combination *Allocasuarina luehmannii* (R.T. Baker) L. Johnson, J. Adelaide Bot. Gard. 6, 1:76 was not effected owing to the inadvertant omission of the page reference of the publication of the basionym.

This combination is now validly published:-

Allocasuarina luehmannii (R.T. Baker) L. Johnson, comb. nov.

Casuarina luehmannii R.T. Baker, Proc. Linn. Soc. N.S.W. 24: 608 (1900), basionym.

Index to Volume 7

Names

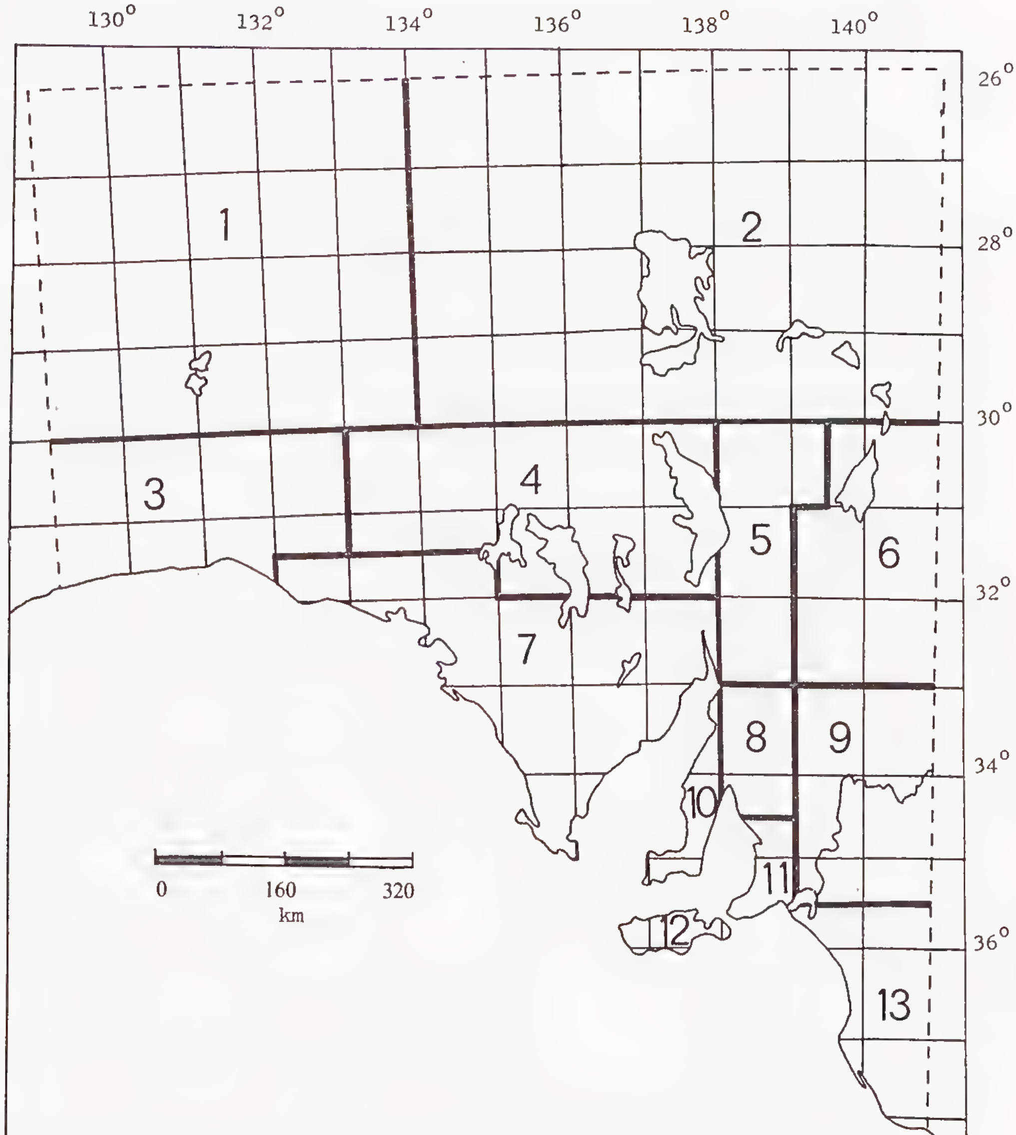
New names and combinations are in **bold**. Synonyms, misapplied, misspelt, illegitimate or invalid names are in *italics*. Names of taxa above genus are in CAPITALS.

Page numbers

Page numbers in **bold** refer to the main taxonomic treatment. Page numbers asterisked (*) refer to figures and maps.

REGIONS OF SOUTH AUSTRALIA ADOPTED BY THE STATE HERBARIUM — ADELAIDE

1. North-western
2. Lake Eyre Basin
3. Nullarbor
4. Gairdner-Torrens Basin
5. Flinders Ranges
6. Eastern
7. Eyre Peninsula
8. Northern Lofty
9. Murray
10. Yorke Peninsula
11. Southern Lofty
12. Kangaroo Island
13. South-eastern



Typeset by P. & L. REPRODUCTIONS PTY. LTD.
Printed by AUSTRALIAN PRINTING SPECIALISTS

JOURNAL of the ADELAIDE BOTANIC GARDENS

CONTENTS